



Conjurunup Creek Pipehead Dam Catchment Area Drinking Water Source Protection Plan

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Conjurunup Creek Pipehead Dam catchment area : drinking water source protection plan : integrated water supply system

DEPARTMENT OF ENVIRONMENT AND CONSERVATION

Integrated Water Supply System



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CONJURUNUP CREEK PIPEHEAD DAM
CATCHMENT AREA
DRINKING WATER SOURCE PROTECTION PLAN

INTEGRATED WATER SUPPLY SYSTEM

Prepared by
Water Resources Division
Department of Environment

DEPARTMENT OF ENVIRONMENT
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Foreword

The Department of Environment (DoE) has prepared this Drinking Water Source Protection Plan (DWSPP) to report on the activities and risks to water quality within the Conjurunup Creek Pipehead Dam Catchment Area and to recommend management strategies to minimise the identified risks.

A safe drinking water supply is critical to the wellbeing of a community and catchment protection is necessary to help avoid, minimise or manage risks to water quality in Public Drinking Water Source Areas (PDWSA). The DoE is committed to protecting these areas to ensure the continued supply of 'safe, good quality drinking water' to consumers to protect public health now and in the future.

The Australian Drinking Water Guidelines recommend a multiple barrier 'catchment to consumer' approach to protect public drinking water. The protection and management of a PDWSA is the 'first barrier', with subsequent barriers implemented at the water storage, treatment and distribution stages of a water supply system. Catchment protection includes:

- Understanding the catchment, the hazards and hazardous events that can compromise drinking water quality; and
- developing and implementing preventive strategies and operational controls necessary to ensure the safest possible raw water supply (i.e. before treatment).

This Plan details the location and boundary of the drinking water catchment, which provides potable water to the Integrated Water Supply System. It discusses existing and future usage of the water source, describes the water supply system, identifies risks and recommends management approaches to maximise protection of the catchment.

The Plan should be used to guide State and local government land use planning decisions in Western Australia. This DWSPP should be recognised in the Shire of Murray Town Planning Scheme and other local planning strategies and plans, consistent with the Western Australian Planning Commission's Statement of Planning Policy No. 2.7 *Public Drinking Water Source Policy*. Other stakeholders should use this document as a guide for protecting the quality of water in the PDWSA.

The process involved in the preparation of a DWSPP is as follows:

Stages in development of a DWSPP	Comment
1 Prepare 'Drinking Water Source Protection Assessment' document	Assessment document may be prepared following catchment survey and preliminary information gathering from State and local government authority stakeholders. This stage is completed by the DoE or a Water Service Provider.
2 Undertake stakeholder consultation	Advice sought from key stakeholders. If a Stage 1 Assessment is available it will be used as a tool for background information and discussion.
3 Prepare Draft DWSPP	Draft DWSPP developed taking into account input from identified stakeholders and any additional relevant information on the catchment.
4 Release Draft DWSPP for public comment	Draft DWSPP released for a six week public consultation period.
5 Publish DWSPP	The Plan is published after considering advice received in submissions on the Draft Plan. Recommendations to protect the drinking water catchment are provided. The Plan is available from the Department's website: < http://drinkingwater.environment.wa.gov.au >.

Contents

Summary	1
1 Introduction	2
1.1 Water supply system	2
1.2 Existing water source protection	2
1.3 Water resource allocation	2
1.4 Future water supply system	2
2 Catchment description	5
2.1 Climate	5
2.2 Physiography and vegetation	5
2.3 Hydrology	5
3 Water quality and treatment	6
3.1 Water quality	6
3.2 Water treatment	6
4 Land use	7
4.1 Crown land	7
5 Proclaimed area and priority classification	10
5.1 Proclaimed areas	10
5.2 Priority classification	10
5.3 Reservoir Protection Zone	10
6 The impact of drinking water source protection planning	11
6.1 Common areas of concern about the impact of drinking water source protection planning	11
7 Management of potential water quality risks	12
7.1 Protection objectives	12
7.2 Potential water quality risks	12
7.3 Land use planning	13
7.4 Surveillance and by-law enforcement	13
7.5 Best management practices	13
7.6 Emergency response	14
7.7 Recommended protection strategies	14
8 Recommendations	29

9 Glossary31

10 References32

Acronyms34

Appendices

Appendix 1 Protecting our Public Drinking Water Source Areas35

Appendix 2 Water quality analysis44

Appendix 3 Land use compatibility in Public Drinking Water Source Areas46

Appendix 4 Best management practice documents for activities in PDWSAs62

Figures

Figure 1. Conjurunup Creek Pipehead Dam Catchment Area locality plan3

Figure 2. Conjurunup Creek Pipehead Dam Catchment Area4

Figure 3. Conjurunup Creek Catchment Area land use and tenure9

Figure 4. Reservoir Protection Zone and priority classification for Conjurunup
Creek Pipehead Dam Catchment Area15

Tables

Table 1. Land use, potential water quality risks and recommended strategies16

Summary

The Conjurunup Creek Pipehead Dam Catchment Area is located approximately 75 km south of Perth in the Shire of Murray. The dam is a strategic source of public drinking water for the Integrated Water Supply System. The Conjurunup Creek Pipehead Dam Catchment Area was proclaimed under the *Metropolitan Water Supply, Sewerage and Drainage Act 1909* in 1982 to ensure protection of the water source from potential contamination.

This Plan has been developed to protect drinking water quality for public health. The Plan:

1. Identifies potential drinking water quality contamination risks from land use activities within the catchment; and
2. recommends strategies to manage these potential risks whilst recognising current land use rights.

Conjurunup Creek catchment is entirely State Forest vested with the Conservation Commission of Western Australia and managed by the Department of Conservation and Land Management and the Water Corporation. There is no privately owned land within the catchment. Use of the State Forest includes forest and plantation management, such as fire protection, mining operations by Alcoa World Alumina Australia and a range of recreation. Alcoa's operations include mining, the conveyor and access roads; the crusher and main workshop were relocated to the North Dandalup Pipehead Dam Catchment Area in December 2004. Recreation in the catchment includes authorised activities such as bike riding on the Munda Bididi Trail. Some unauthorised activities, such as fishing and marroning, rubbish dumping, camping, swimming and off-road vehicle use, also occur in the catchment.

The following strategies are recommended to protect the Conjurunup Creek drinking water source:

- The existing Reservoir Protection Zone needs to be clearly identified within the catchment.
- All Crown land in the catchment should be managed for Priority 1 source protection.
- The catchment, including the Reservoir Protection Zone and the proposed priority classification, should be recognised in the relevant land planning strategies and schemes, specifically the Shire of Murray Town Planning Scheme.
- Best management practices for the current land uses in the catchment should be implemented.

Priority classification areas and the Reservoir Protection Zone provide guidance on appropriate land use planning decisions and define areas where *Metropolitan Water Supply, Sewerage and Drainage Act* by-laws are available to protect this drinking water catchment. These areas and zones recognise established approved land uses but may constrain expansion of those uses or development of alternative future land uses. Implementation of best management practices in the design, construction and operational stages are recommended for existing or approved land uses.

1 Introduction

The Conjurunup Creek Pipehead Dam Catchment Area is located in the Shire of Murray, approximately 13 km north-east of Pinjarra and 75 km south of Perth.

Figure 1 shows the location of the Conjurunup Creek Pipehead Dam and the catchment area.

The reservoir is a strategic source of public drinking water for the Integrated Water Supply System (IWSS), which provides water to Perth, Mandurah, Pinjarra, Harvey, the Goldfields and Agricultural regions. The dam contributes approximately 3.0% of the total water supply.

The objective of this Plan is to recommend protection strategies to ensure land uses and activities in the Conjurunup Creek Pipehead Dam Catchment Area are managed to protect the drinking water quality of this source.

1.1 Water supply system

The Conjurunup Creek Pipehead Dam was constructed in 1991. The dam is a concrete embankment dam which is 120 m long and 13 m high. The dam has a capacity of 190,000 m³ with a surface area of 6.5 ha and a Full Supply Level of 209 m AHD.

Water from Conjurunup Creek Pipehead Dam is pumped back to North Dandalup Pipehead Dam, which supplies the IWSS. The dam is operated during winter, generally between June and November.

1.2 Existing water source protection

The Conjurunup Creek Pipehead Dam Catchment Area was originally proclaimed in 1982 under the *Metropolitan Water Supply, Sewerage and Drainage (MWSSD) Act 1909*, to ensure protection of the water source from potential contamination. Boundary alterations were made in 1991 and 2000.

Figure 2 shows the Conjurunup Creek Pipehead Dam Catchment Area.

1.3 Water resource allocation

Surface water resource utilisation and conservation in Western Australia is administered by the Department of Environment (DoE) in accordance with the *Rights in Water and Irrigation (RIWI) Act 1914*. Under the *RIWI Act*, the right to use and control surface water is vested with the Crown. This Act requires licensing of surface water abstraction within proclaimed Surface Water Areas. The Conjurunup Creek Pipehead Dam Catchment Area also forms the boundary of the Conjurunup Creek Pipehead Dam Surface Water Area proclaimed under the *RIWI Act*.

1.3.1 Current allocation licence

The current allocation licence for the Conjurunup Creek Pipehead Dam, Surface Water Licence No. 56736, allows the Water Corporation (WC) to divert up to 6 GL per annum from Conjurunup Creek. This licence is issued for the purpose of providing potable water for public water supply. Due to reduced rainfall and streamflow, the annual abstraction in 2002/03 was 3.67 GL and in 2003/04 was 5.14 GL.

1.4 Future water supply system

It is intended to continue to use the Conjurunup Creek Pipehead Dam for supply to the IWSS.

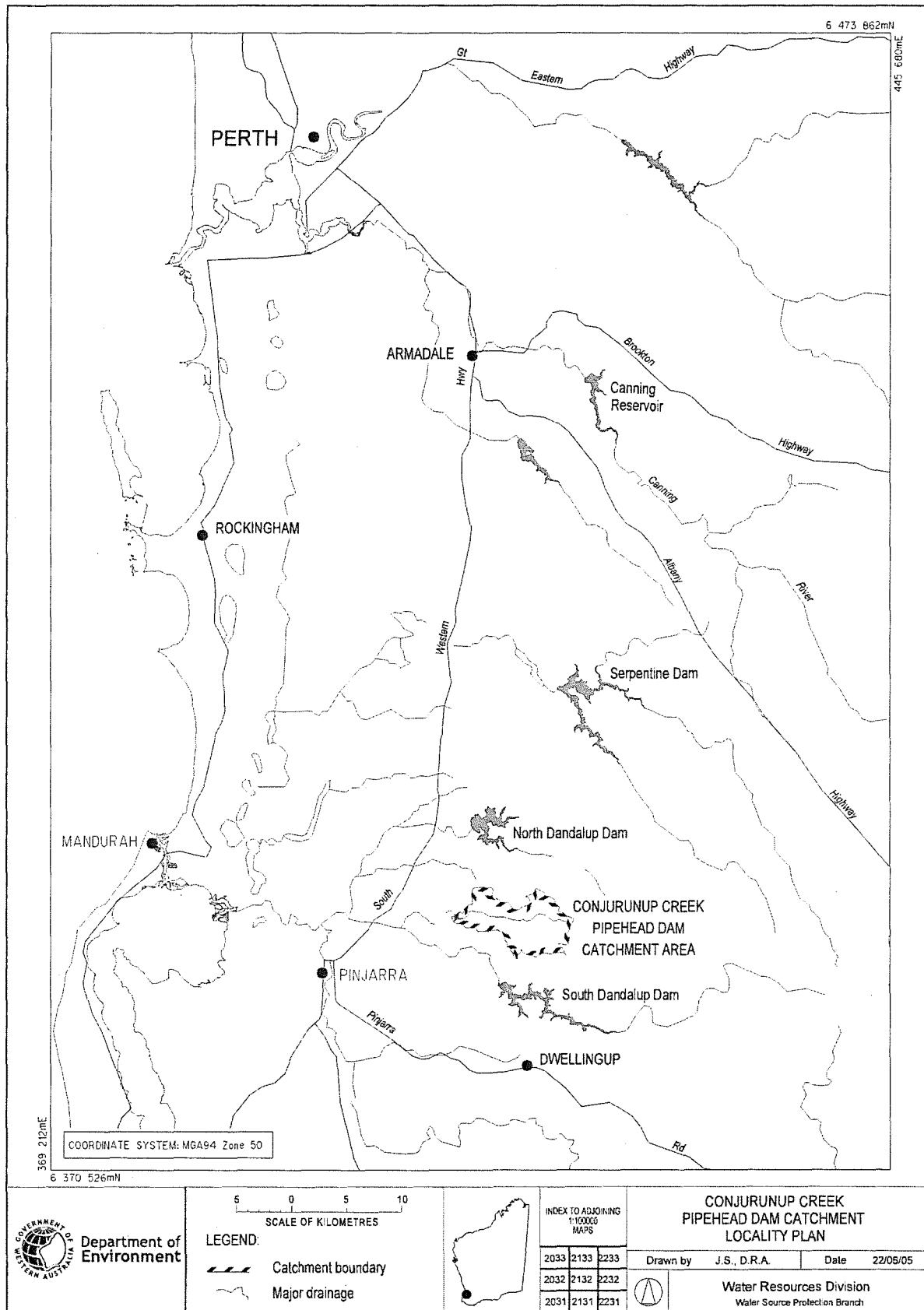


Figure 1. Conjurunup Creek Pipehead Dam Catchment Area locality plan

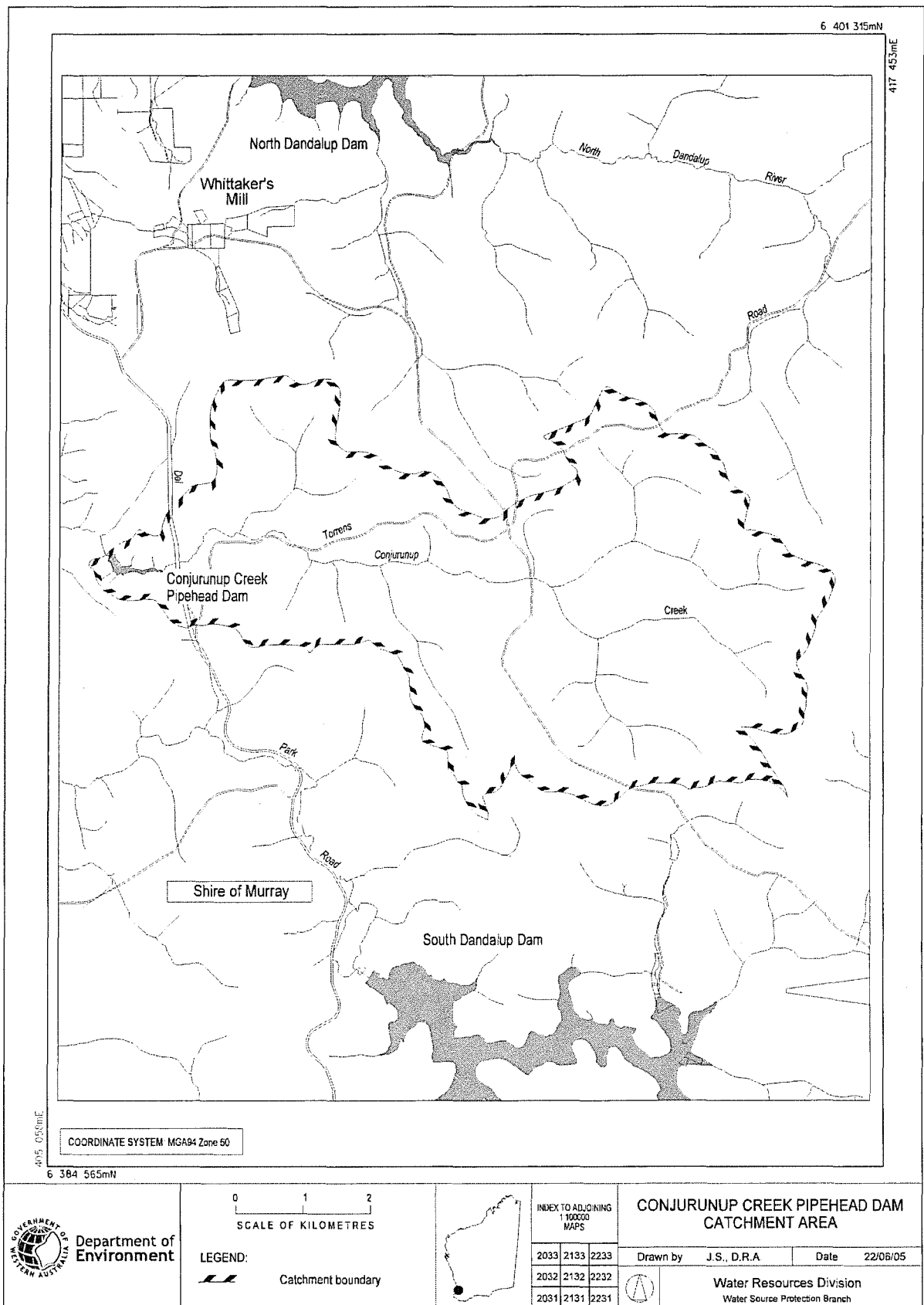


Figure 2. Conjurunup Creek Pipehead Dam Catchment Area

2 Catchment description

2.1 Climate

The catchment is subject to a Mediterranean type climate with hot, dry summers and cool, wet winters.

The long-term average rainfall in the region was approximately 1200 mm and the average annual pan evaporation was approximately 1680 mm per annum (PWD, 1984). Since the mid 1970s, the south west of Western Australia has experienced a 10 to 20% decline in its long-term average rainfall. The average rainfall for the catchment has declined to approximately 1000 mm per annum.

2.2 Physiography and vegetation

The Conjurunup Creek catchment is located in the Darling Scarp. The catchment is characterised by moderate relief with Archaean granite and gneissic rocks covered with lateritic soils (PWD, 1984).

Low lying areas in the catchment, with a high risk of erosion, include the Helena and Murray landforms. The remaining low lying areas and valleys are Yarragil landform with a low to medium risk of erosion. All the upland areas of the catchment are Dwellingup landform and have a low risk of erosion.

Most of the catchment is covered by dry sclerophyll forest, dominated by jarrah (*Eucalyptus marginata*), and to a lesser extent marri (*Corymbia calophylla*). Other eucalypts such as blackbutt (*E. patens*) and flooded gum (*E. rudis*) occur near swamps and watercourses. A dense shrub storey includes the species *Macrozamia reidleyi*, *Hibbertia hypericoides*, *Phyllanthus calyccinus*, *Acacia urophylla*, and *Leucopogon verticillatus*. Understorey trees include *Banksia grandis* and *Allocasuarina fraseriana* (WAWA, 1990).

2.3 Hydrology

The Conjurunup Creek catchment has a total area of 39.2 km².

From 1948 to 2000 the mean annual streamflow of Conjurunup Creek was 9.5 GL. Since the 1970s, there has been a significant reduction in streamflow as a result of low rainfall. From 1975 to 2004 the average annual streamflow was reduced to 7.4 GL. The majority of streamflow occurs between May and November.

3 Water quality and treatment

3.1 Water quality

A wide range of chemical, physical and microbiological properties can affect the health and aesthetic quality of drinking water.

WC routinely monitors the water quality in Conjurunup Creek Pipehead Dam in accordance with the Australian Drinking Water Guidelines (ADWG) (NHMRC & ARMCANZ, 1996). The ADWG are used in Western Australia by the Department of Health (DoH), DoE and WC to assess the quality of our drinking water.

A summary of the results of the comprehensive water quality analyses undertaken by WC is shown in Appendix 2.

Iron and aluminium concentrations have exceeded the 1996 ADWG on occasion. This may be a result of erosion of the soil in the catchment, which is naturally high in these elements. The pH occasionally exceeded the lower value of the ADWG pH range.

The dam is periodically monitored for pesticides, heavy metals and hydrocarbons. Results have indicated that levels of these potential contaminants are well below the ADWG health guidelines.

The microbiological quality of the water is monitored regularly both before and after treatment. Despite significant presence of thermotolerant coliforms (an indicator for potential presence of pathogenic microbes) in raw water, treatment generally removes this contamination. During the reported five-year monitoring period, 44% of samples with a positive thermotolerant coliform count exceeded a count of 20 colony forming units per 100 mL, which is the World Health Organisation (WHO) benchmark for microbiological contamination. The high level of thermotolerant coliforms may be due to the minimal detention time in the dam, therefore preventing time for microbiological breakdown.

In addition to WC monitoring, the turbidity of major tributaries into the reservoir has been monitored intermittently by DoE and Alcoa World Alumina Australia (Alcoa) during mining and rehabilitation operations within the catchment.

3.2 Water treatment

Water from the Conjurunup Creek Pipehead Dam is chlorinated before being pumped back to the North Dandalup Pipehead Dam where it is then chlorinated and floridated before entering the IWSS. Fluosilicic acid is used for treatment of water. Chlorination is the final essential barrier used to ensure good quality public drinking water (NHMRC & ARMCANZ, 1996).

It should be recognised that, although reservoir storage and disinfection by chlorination generally removes microbiological contamination, treatment processes alone cannot be relied upon. Where possible, contamination can and should be prevented or reduced through appropriate land use or activity controls in the catchment area. This approach is endorsed by the ADWG and reflects a 'catchment to consumer' multiple barrier approach for the provision of safe drinking water to consumers.

4 Land use

Land uses in the catchment include:

- Forest and plantation management;
- Mining and gravel extraction; and
- Recreation.

Land use and tenure in the catchment are shown in Figure 3.

4.1 Crown land

State Forest Number 14 covers the entire 39.2 km² of catchment and is vested with the Conservation Commission of Western Australia and managed by the Department of Conservation and Land Management (CALM).

The main road running through the catchment is Del Park Road, which has a heavy traffic load due to nearby mining operations. Fuels and explosives are carried along this road. Del Park Road is the main access link between the towns of North Dandalup and Dwellingup.

4.1.1 Forest and plantation management

Logging last occurred in the north-western part of the catchment during the mid 1980s, the eastern part in the late 1980s and the south-western portion in the early 1990s. Some of these areas were logged to accommodate Alcoa's operations, which began after 1990, while others were selectively felled and left to regenerate. CALM has advised there are no plans for hardwood harvesting in the State Forest within the next 10 years.

Land management by CALM includes fire protection, such as prescribed burning and maintenance of firebreaks. CALM and WC undertake feral animal control (fox baiting, feral pig hunting and trapping) within the catchment.

Firewood collection and other private resource harvesting, including apiaries (4 sites), wildflower picking and seed collection also occur in the State Forest and are licensed by CALM. Occasionally, research projects are undertaken in the State Forest or reservoir.

4.1.2 Mining and gravel extraction

A Special Mining Lease granted to Alcoa under the *Alumina Refinery Agreement Act 1961, No. 3*, exists over the Crown land in the catchment. Under the State Agreement, Alcoa has rights to extract bauxite from Crown land, with associated responsibilities to protect environmental values and rehabilitate mine sites. Alcoa has a comprehensive *Environmental Management Manual* and Mining and Management Programs which are reviewed and audited by the Mining and Management Program Liaison Group (MMPLG).

Alcoa commenced mining operations within the Conjurunup catchment in the late 1970s. The removal of bauxite ore from within the Conjurunup catchment ceased in 2004. In December 2004, Alcoa moved its crusher from White Road and its main workshop from the Huntly mine to the McCoy crusher site in the North Dandalup Pipehead Dam Catchment Area. Alcoa will continue to operate facilities (offices, roads, small workshops, conveyor belts, powerlines and pipelines) within the catchment to support the Huntly mine operations for at least another 25 years.

Some of the sources of risk associated with mining operations in the catchment are septic and sewage treatment systems, hydrocarbon spills from mining equipment and turbidity from areas cleared for mining pits, roads and infrastructure. All cleared areas have drainage structures (such as sediment sumps) designed to contain sediment and minimise the discharge of turbid water into the forest or streamzones. The majority of hydrocarbon spills are due to hydraulic hose failures on earthmoving equipment used for completing rehabilitation operations. When spills do occur they are cleaned up immediately.

A regular inspection and maintenance program is in place for the septic tank systems at the White Road conveyor transfer station. Domestic wastewater passes through these septic tanks before discharging into leach drains located within the catchment.

There is also an on-site biological aeration treatment unit (Biomax) that treats sewage water from the Huntly office facilities. The effluent from the units is reticulated into rehabilitated pits. Regular inspections and monitoring are undertaken to ensure that effluent is suitable for discharge.

Samples of effluent from the sewage treatment systems are tested against standards developed using the National Water Quality Management Strategy Paper No. 11 *Australian Guidelines for Sewerage Systems – Effluent Management* (ARMCANZ & ANZECC, 1997).

As at 31st December 2004, approximately 1,603 ha (44%) of the catchment had been cleared for mining purposes and 1,438 ha (40%) had been rehabilitated with native species. Rehabilitation operations are still in progress and will be completed by 2007.

North of Conjurunup Creek and east of Del Park Road is an abandoned gravel quarry which is being rehabilitated by CALM.

4.1.3 Recreation

Activities within the catchment include approved and unauthorised recreation resulting from open access to the catchment.

The Munda Biddi Trail is a cycling trail which enters the catchment from the north and passes straight through the middle of the catchment, upstream of the dam, crossing Torrens Road before continuing south out of the catchment. The trail is located approximately 3 km from the dam and passes as close as 50 m from creeks.

The trail attracts approximately 10,000 cyclists annually. Publicity associated with the trail, including the *Caring for the Trail – Code to Off-road Cycling*, and CALM management prescriptions will discourage unauthorised off-trail cycling in the catchment. The closest designated campsite to the trail is Whittakers Mill (Figure 3), less than 5 km from the dam outside the catchment boundary. CALM and the Munda Biddi Trail Foundation manage the Munda Biddi Trail.

The Bibbulmun Track used to run through the catchment, approximately 3 km upstream of the dam, but was diverted further east outside of the catchment before 1990 (WAWA, 1990).

Unauthorised activities occur in the catchment, including swimming, fishing, marroning, hunting, camping, dog exercising, off-road driving and rubbish dumping. These activities are prohibited in the reservoir and catchment under the *MWSSD Act* by-laws. The dam is not easily accessible, which reduces the incidence of direct human contact with the water body.

Gravel pits can attract illegal recreation and are often used by members of the public for the dumping of stolen cars and rubbish.

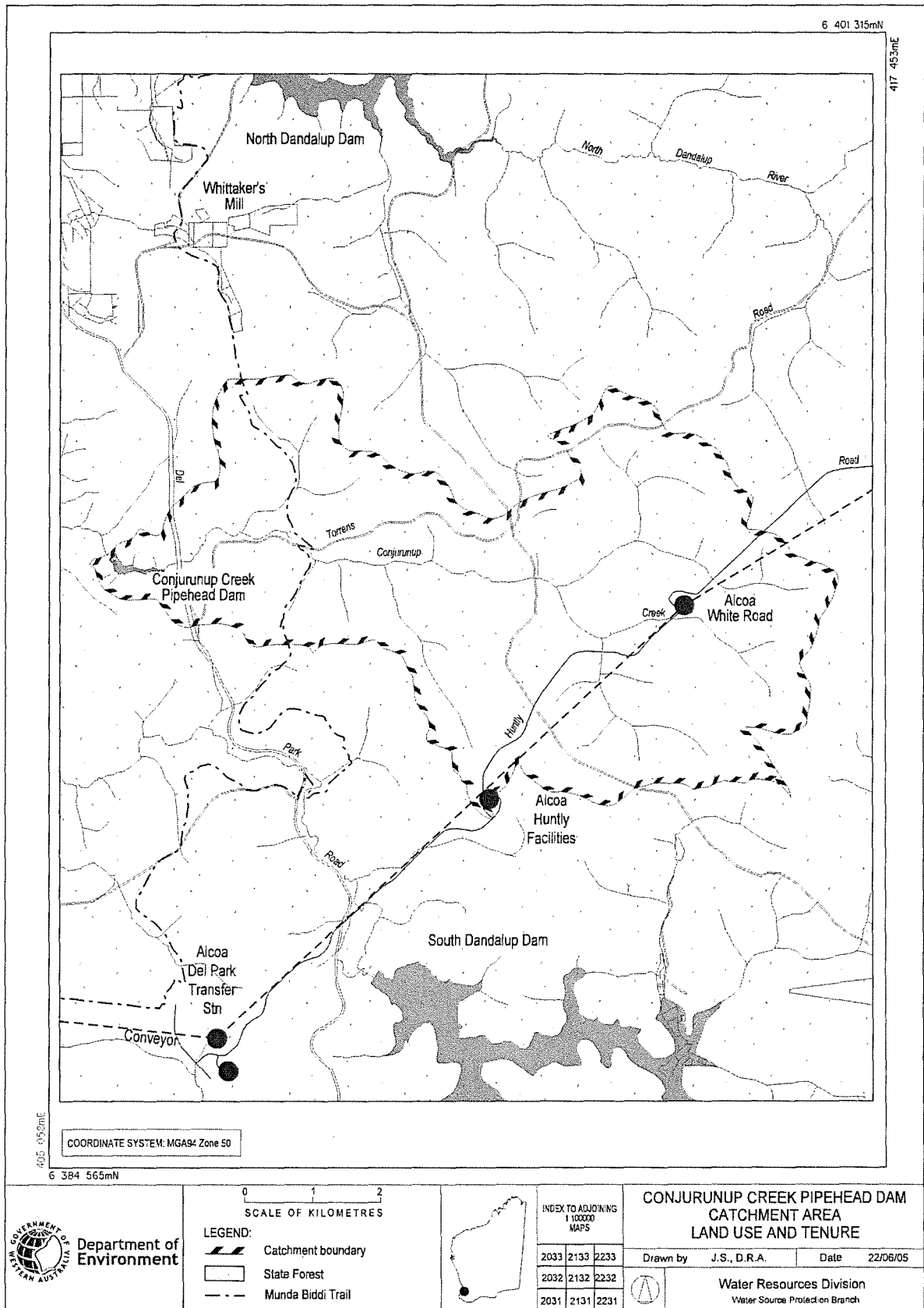


Figure 3. Conjurunup Creek Catchment Area land use and tenure

5 Proclaimed area and priority classification

5.1 Proclaimed area

The Conjurunup Creek Pipehead Dam Catchment Area was proclaimed on the 3rd December 1982 under the *Metropolitan Water Supply, Sewerage and Drainage (MWSSD) Act 1909*. Boundary alterations were undertaken in 1991 and 2000.

5.2 Priority classification

An explanation of priority classifications and the land use compatibility with each priority classification is provided in Appendix 3.

All land in the catchment should be managed for Priority 1 (P1) source protection. The objective of this priority classification is to protect water quality according to the principle of risk avoidance.

A P1 source protection classification for this catchment is appropriate as:

- The Conjurunup Creek Pipehead Dam is a strategic source of public drinking water for the IWSS and should be afforded the highest level of protection.
- Most existing, approved land use practices can be managed for P1 source protection with the use of best management practices.
- The land is State Forest.

Alcoa's major infrastructure in the catchment, including the offices, small workshops and wastewater treatment facilities, are incompatible with a P1 classification and should be managed as non-conforming activities. In order to be acceptable within a P1 area, best management practices and compliance with licence and agreement conditions are incorporated into their operations.

5.3 Reservoir Protection Zone

To protect the reservoir from immediate risks to water quality, such as human contact, a Prohibited Zone (PZ), also known as a Reservoir Protection Zone (RPZ), exists within 2 km of the upper water level of the reservoir. The RPZ is a key barrier in the 'catchment to consumer' multiple barrier approach for protecting the reservoir and its drinking water quality (NHMRC & ARMCANZ, 1996).

The RPZ includes the reservoir itself but does not extend outside the catchment area or downstream of the dam wall. Figure 4 shows the boundary of the RPZ.

Unauthorised entry to the RPZ, except on public or private roads, is prohibited under the *MWSSD Act* by-laws. Entry to the RPZ requires specific approval from WC (as the agent with delegated responsibility from DoE).

6 The impact of drinking water source protection planning

General issues raised throughout the State regarding the impact of water source protection planning are addressed below.

6.1 Common areas of concern about the impact of drinking water source protection planning

6.1.1 Existing and future land uses and activities

DoE's water source protection planning recognises existing approvals and does not prohibit currently approved land use activities, even where they are considered incompatible with the assigned priority classification.

When a landowner applies to the local authority to expand an existing operation or develop the land for a particular use, DoE will provide advice based on the Water Quality Protection Note *Land Use Compatibility in Public Drinking Water Source Areas* (Appendix 3) and the relevant priority classification of the land.

6.1.2 Compensation for development constraints

The issue of compensation is often raised through water source protection planning. The existing water source protection legislation, the *MWSSD Act*, does not contain any provision for compensation when a protection area is proclaimed and the *MWSSD Act* by-laws become applicable. In this case, there are no private lots within the catchment.

7 Management of potential water quality risks

7.1 Protection objectives

The objective of this Plan is to protect drinking water quality for public health, while recognising current approved land uses.

The Priority 1 classification proposed for this catchment has the fundamental water quality objective of risk avoidance.

7.2 Potential water quality risks

The potential risk to water quality associated with activities in the catchment includes pathogen contamination, turbidity, and chemical contamination (including pesticides, hydrocarbons and nutrients). Pathogens pose the most significant risk to public health, human and domestic animal contact with water involves an immediate threat of pathogen contamination.

Many pathogens are commonly known to contaminate water supplies worldwide. These include bacteria (e.g. *Salmonella*, *Escherichia coli* and *Cholera*), parasites (e.g. *Cryptosporidium*, *Giardia*) and viruses. These pathogens generally arise from faecal contamination. In May 2000, bacterial pathogens from cattle manure contaminated the drinking water supply of the town of Walkerton, Canada. Approximately 2,300 individuals suffered gastrointestinal illnesses and 7 people died.

The percentage of humans in the world who carry various pathogens, and hence have the potential to contaminate, varies. For example, it is estimated between 0.6 to 4.3% of people are infected with *Cryptosporidium* worldwide and 7.4% are infected with *Giardia* (Geldreich, 1996). In 1998, Sydney's drinking water supply became contaminated with these parasites and 'boil water' notices were issued to 3 million residents.

The viability of pathogens in surface water will also affect the risk. For example, *Salmonella* is viable for two to three months, *Giardia* may still infect after one month in the natural environment (Geldreich, 1996) and *Cryptosporidium* oocysts (cells containing reproductive spores) can survive weeks to months in fresh water (NHMRC & ARMCANZ, 2004). These survival times enable pathogen contamination to occur many kilometres away from the original source.

The combination of human pathogen infection, the viable life of the pathogen and human contact with the water, or the presence of humans near the reservoir or feeder streams, creates a serious risk to public drinking water quality and public health. Preventing the presence of pathogens in the water source is the most effective barrier in avoiding a public health risk.

Table 1 summarises the water quality risks associated with existing land uses and activities within the catchment which have the potential to pose some risk to the quality of the water source. Hazards identified as high risks include turbidity associated with wildfires, roads and tracks; and pathogens associated with feral animals and people fishing or marroning within the catchment.

Following storm events, turbidity in the dam can exceed 5 NTU. Detention in North Dandalup Pipehead Dam allows turbid flows to settle. Mining and its operations in the catchment have the potential to contribute to erosion and turbidity.

Alcoa adopts best management practices to minimise the risk of turbidity associated with its operations, in accordance with its *Environmental Management Manual* (Alcoa, 2005) and *Bauxite Mining in Water Supply Catchments – Water Conservation and Quality Protection* (McIntosh & Cronin, 2003). Del Park Road, 1 km upstream of the dam, has erosion problems along batters and road drains due to high traffic volumes. Improved design and maintenance could reduce erosion and associated turbidity.

7.3 Land use planning

The establishment of appropriate protection mechanisms in statutory land use planning processes is necessary to secure the long-term protection of water sources.

It is recommended that the Conjurunup Creek Catchment Area and the priority land classification be recognised in the Town Planning Scheme of the Shire of Murray, consistent with the Western Australian Planning Commission's Statement of Policy 2.7 *Public Drinking Water Source Policy*.

DoE provides advice on the compatibility of land uses within the proposed priority classification areas based on the Water Quality Protection Note *Land Use Compatibility in Public Drinking Water Source Areas* (Appendix 3). Development and works proposals in the catchment that are likely to impact on water quality or are inconsistent with the *Land Use Compatibility in Public Drinking Water Source Areas* guidance document should be referred to DoE's Kwinana Peel Regional Office for assessment and recommendation.

7.4 Surveillance and by-law enforcement

The Conjurunup Creek Pipehead Dam Catchment Area has been proclaimed under the *MWSSD Act*, enabling the by-laws of the Act to be used to control potentially contaminating activities within the catchment.

DoE has delegated the responsibility for surveillance and associated by-law enforcement in the catchment to WC, who report annually to DoE on the surveillance program and associated issues.

By-law enforcement, through on-ground surveillance of land uses and activities, is a critical mechanism in protecting the quality of drinking water sources. WC and CALM Ranger communication with visitors to the catchment also assists in increasing public awareness of the need to protect drinking water quality.

The use of signs and other informative material is also an important component of water quality protection for those who visit the catchment.

7.5 Best management practices

Best management practices for land use activities are encouraged to help protect water quality. They are often in the form of an industry code of practice or an environmental guideline. Guidance documents are usually developed in consultation with industry groups, relevant stakeholders and State government agencies.

Best management practices can be developed for an individual enterprise or have a local or regional focus and must consider the full range of economic, social and environmental issues associated with land, water and vegetation use. Development of best management practices must also take into consideration the needs and concerns of users, consumers and the wider community (ARMCANZ & ANZECC, 1996).

The potential risks to water quality due to current land uses can be significantly reduced by the implementation of best management practices. For example:

- Retention of vegetation along streamlines (refer to DoE's Water Quality Protection Note *Buffers to Sensitive Water Resources (draft)*).
- Appropriate pesticide application practices as detailed in Statewide Policy No.2 *Pesticide Use in Public Drinking Water Source Areas* (WRC, 2000) and Public Service Circular 88 *Use of Herbicides in Water Catchment Areas* (DoH, 1993).
- Appropriate buffers should be maintained between drinking water resources and bauxite mining operations. Alcoa maintains a 100 m buffer between the top water level of drinking water reservoirs and any mining operations. In addition, Alcoa self-imposes a Water Resource Sensitive Zone, which extends 500 m from the reservoir top water level and includes a 200 m stream buffer (from the centre of the streamzone) for 1 km upstream of the top water level. Within this zone, Alcoa undertakes risk assessment to ensure that mining or infrastructure has no impact on the water resource. Strategies in place include maximising mine development work in summer, mining of pits along contours to ensure that stormwater runoff is fully contained and early rehabilitation of significant areas up-slope of the mining face.

The implementation of best management practices for land use activities in the catchment should be encouraged as it assists in protecting water quality. A reference list of best management practices for some of the activities in the catchment is provided in Appendix 4.

7.6 Emergency response

Discharge of chemicals during unforeseen incidents and the use of chemicals during emergency response can cause contamination of water sources. The Shire of Murray Local Emergency Management Committee, through the Peel Emergency Management District, should be familiar with the location and purpose of the catchment boundary. A locality plan should be provided to the Fire and Rescue Services headquarters for the HAZMAT Emergency Advisory Team. WC should have an advisory role to any HAZMAT incident in the catchment.

Personnel who deal with WESTPLAN - HAZMAT incidents within the area should be given ready access to a locality map of the Conjurunup Creek Pipehead Dam Catchment Area. These personnel should receive training to ensure an understanding of the potential impacts of spills on the surface water resource.

Alcoa has approved emergency response plans that address risks associated with its operations within the catchment.

7.7 Recommended protection strategies

Table 1 identifies the potential water quality risks associated with existing land uses in the catchment and recommends protection strategies to manage these risks.

The potential water quality risks were identified and the resulting management priorities were designated using a risk assessment process. Strategies have been developed in line with the ADWG (NHMRC & ARMCANZ, 1996).

The discussion and recommended strategies balance the need to protect water quality now and in the future with the rights of land holders to continue to utilise their land for lawful purposes.

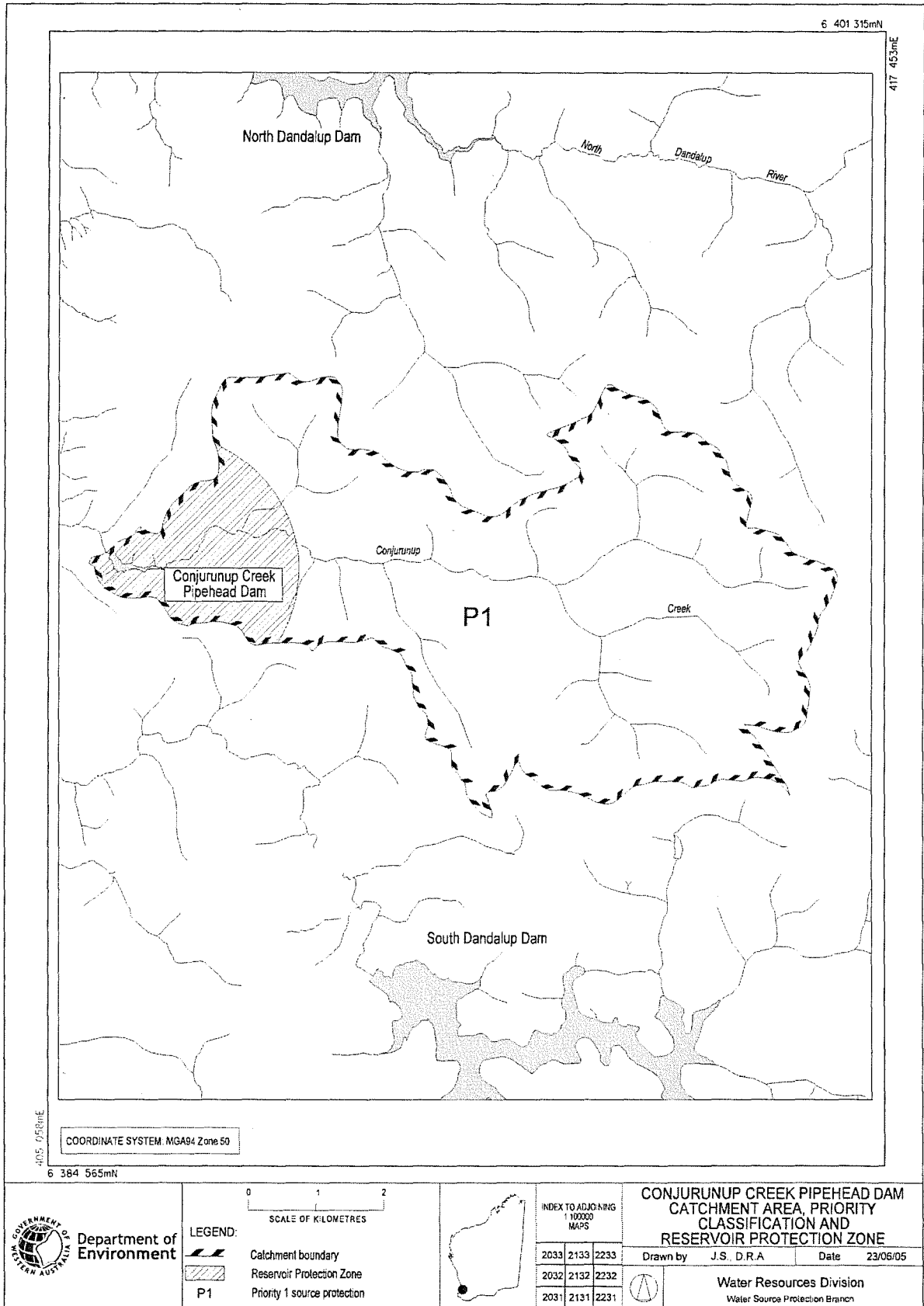


Figure 4. Reservoir Protection Zone and priority classification for Conjurunup Creek Pipehead Dam Catchment Area

Table 1. Land use, potential water quality risks and recommended strategies

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<i>State Forest</i>				
Native forest timber harvesting	The risks associated with hardwood harvesting include: <ul style="list-style-type: none"> • Turbidity due to log handling practices, and the use of unsealed roads and tracks; • Fuel spills from vehicles and machinery; • Pathogens due to human presence 	Medium	The impact of hardwood harvesting on water quality can be minimised through proper management. Water quality protection is a requirement of the <i>Conservation and Land Management Act 1984</i> , which recognises the importance of water as a resource.	<i>Acceptable activity with best management practices.</i> <ul style="list-style-type: none"> • Continue to review detailed (1-year and 5-year) harvesting plans during the planning phase to ensure water quality protection objectives are included. • Inspect water quality protection measures on site. • Where possible avoid logging in the RPZ, and within 200 m of the reservoir. • Ensure contract specifications recognise water quality protection objectives, including the use of chemical toilets during periods of intensive activity on the site. Chemical toilets are prohibited within the RPZ or within 100 m of the reservoir or its tributaries. • Ensure timber harvesting occurs in accordance with the <i>Contractors' Timber Harvesting Manual – South West Native Forests</i> (FPC, 2003) and the <i>Code of Practice for Timber Harvesting</i> (CALM, 1999). • Update forestry manuals and codes in accordance with FPC, CALM, WC and DoE requirements.
		Medium	Timber harvesting occurs in accordance with the <i>Contractors' Timber Harvesting Manual – South West Native Forests</i> (FPC, 2003) and the <i>Code of Practice for Timber Harvesting</i> (CALM, 1999). These guidelines indicate that logging can occur as close as 500 m from the top water level of water reservoirs. Harvesting could therefore occur within the RPZ.	
		Medium	The potential risks to water quality of harvesting within 200 m of the reservoir and feeder streams are more acute. Increased turbidity is evident from harvesting operations. Best practice management is required.	
			FPC and CALM forestry operations are governed by the <i>Forest Management Plan 2004-2013</i> .	

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<i>State Forest</i>				
Bauxite mining	<p>The potential water quality risks associated with bauxite mining are:</p> <ul style="list-style-type: none"> • Turbidity from erosion of cleared and excavated land, and the use of unsealed roads and tracks; • Hydrocarbon contamination from fuel spills, vehicles and machinery; • Pathogen contamination from increased human activity in the catchment. 	<p>Low</p> <p>Low</p> <p>Medium</p>	<p>Alcoa holds a Special Mining Lease under the <i>Alumina Refinery Agreement Act 1961</i>. Department of Industry Resources (DoIR) license Alcoa's bauxite mining in the catchment.</p> <p>A multi-agency group, the Mining and Management Program Liaison Group (MMPLG), oversees the implementation of the State Agreement Act. This includes reviewing Alcoa's five-year mine plan and enforcing environmental (including water quality protection) conditions where appropriate. Membership includes the DoE, CALM, WC and DoIR.</p> <p>The Mine Operations Group (MOG) reviews the clearing plans and inspects areas in the field. The group may modify proposals that may affect water quality in the reservoir. Membership includes CALM, WC, DoIR, DoE and FPC.</p> <p>Alcoa has programs in place for sediment control, prevention of erosion and monitoring. Results show that mining is not contributing a measurable amount to occasionally high turbidity levels in the dam. Areas identified as high risk to water quality are cleared, mined and rehabilitated in the shortest possible time, usually within a six-month period over summer.</p>	<p><i>Acceptable if operated in compliance with the conditions imposed by MMPLG.</i></p> <ul style="list-style-type: none"> • Ensure the conditions imposed by the MMPLG specifically pertaining to water quality protection are adhered to. • Ensure Alcoa continues to manage water protection in accordance with its <i>Environmental Management Manual</i> (updated bi-annually). • Ensure Alcoa operates according to the <i>Working Arrangements Between Alcoa World Alumina Australia, the Department of Environment and the Water Corporation covering Alcoa's Mining Operations in the Darling Range</i>. • Ensure Alcoa's monitoring program continues.

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<i>State Forest</i>				
Bauxite mining (continued)			Much of the catchment east of Del Park Road was cleared to accommodate Alcoa operations, which began in 1990. As at 31st December 2004, 1,603 ha (44%) of the Conjurunup Creek catchment had been mined, however 85% of this area had been rehabilitated. Mining has now been completed. Mining infrastructure will stay in the catchment for at least another 25 years.	
Rehabilitation of mined areas	<p>The potential risks to water quality include:</p> <ul style="list-style-type: none"> • The leaching of nutrients into drinking water from the use of fertilisers; • Fuel spills from vehicles and machinery. 	<p>Low</p> <p>Low</p>	<p>A rehabilitation prescription is agreed between Alcoa and CALM, and is included in the <i>Alcoa /CALM Working Arrangements</i>. Annual rehabilitation reports are submitted to CALM to certify that Alcoa has achieved the required standards for rehabilitation success.</p> <p>The rehabilitation is monitored at 9 months and 15 months to ensure it meets completion criteria. Long- term successional monitoring of flora and fauna is also carried out.</p> <p>Fertilisers are applied once, initially in August following seeding. Fertiliser is restricted to rehabilitated areas only. Fertiliser is not applied to streamzones.</p> <p>As at 31st December 2004, 1,438.7 ha (40% of the catchment) had been rehabilitated. All of the overstorey rehabilitation is native, dominated by 80% jarrah and 20% marri. All of the mined areas will be rehabilitated by 2007.</p>	<p><i>Acceptable if operated in compliance with conditions imposed by MMPLG.</i></p> <ul style="list-style-type: none"> • Ensure the conditions imposed by the MMPLG specifically pertaining to water quality protection are adhered to. • Ensure Alcoa continues to manage water protection in accordance with its <i>Environmental Management Manual</i>. • Ensure Alcoa operates according to the <i>Working Arrangements Between Alcoa World Alumina Australia, the Department of Environment and the Water Corporation covering Alcoa's Mining Operations in the Darling Range</i>. • Ensure the <i>Alcoa/CALM Working Arrangements</i> are continued. • Ensure compliance with Policy Statement No. 10 <i>Rehabilitation of Disturbed Land</i> (CALM, 1986). • Ensure Alcoa's monitoring program continues.

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<i>State Forest</i>				
Mining operations • Workshops • Conveyor belt • Offices	The potential risks to water quality include: <ul style="list-style-type: none"> • The use, storage and disposal of chemicals which have the potential to leak or spill; • Fuel spills from vehicles, heavy machinery and storage tanks; • Risk of pathogen contamination due to leakage of septic tank system or leach drains, or operation failure; • Increased turbidity due to clearing and the use of vehicles on unsealed roads and tracks. 	Low Low Medium Medium	<p>The crusher and main workshop were relocated outside the Conjurunup Creek catchment in December 2004.</p> <p>Fuels and chemicals are stored in bunded areas in accordance with the <i>Explosives and Dangerous Goods Act 1961</i>. There are no underground storage tanks and all underground pipes are double sleeved. The chemicals stored on site are mainly sulphuric acid, battery acid and detergents.</p> <p>Alcoa have an Ampress unit that treats wastewater to the DoE licence standard, and <i>Australian Guidelines for Sewerage Systems – Effluent Management</i> standards and then releases this water into the catchment. All discharges have met the required standards.</p> <p>In addition to this, Alcoa is moving towards zero discharge from workshops and associated infrastructure.</p> <p>Septic systems discharge effluent from the amenities rooms into leach drains within the catchment. The samples from it have always been of acceptable quality.</p> <p>The conveyor belt may pose a risk if it broke. In the event of the belt breaking, there are protective measures to prevent ore from directly entering the stream. There are no chemicals or oils stored along the length of the conveyor belt.</p>	<p><i>Acceptable if operated in compliance with conditions imposed by MMPLG.</i></p> <ul style="list-style-type: none"> • Ensure the conditions imposed by the MMPLG specifically pertaining to water quality protection are adhered to. • Ensure Alcoa continues to manage water protection in accordance with its <i>Environmental Management Manual</i>. • Ensure Alcoa operates according to the <i>Working Arrangements Between Alcoa World Alumina Australia, the Department of Environment and the Water Corporation covering Alcoa's Mining Operations in the Darling Range</i>. • Ensure Alcoa's monitoring program continues.

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<i>State Forest</i>				
Fire management <ul style="list-style-type: none"> • Fuel reduction burning • Firebreaks • Water points 	Fuel reduction burning and the construction and maintenance of firebreaks have the potential to: <ul style="list-style-type: none"> • Increase turbidity; • Promote carbon and nutrient contamination. The potential risks associated with the construction and access of water points for fire fighting include: <ul style="list-style-type: none"> • Turbidity from the use of unsealed roads and tracks; • Fuel spills from vehicles and machinery; • Pathogens from direct contact of firefighters with water bodies. 	Medium Low Medium	Wildfire minimisation by fuel reduction burning is an established essential land management practice in the catchment and should be managed to limit the potential for turbid runoff into the reservoir. Firebreaks are generally cut in the event of an emergency and are not cut on a routine basis. They may be constructed for pre-suppression purposes or to meet biodiversity outcomes. Turbidity may result in areas of steeper slopes close to the reservoir and its tributaries.	<i>Acceptable activity with best management practices.</i> <ul style="list-style-type: none"> • Establish specific guidelines related to water quality protection for consideration in the burning prescription. Liaise closely with CALM to ensure that these guidelines are incorporated into CALM's <i>Fire Operations Manual</i> and that protocols are put in place for effective communication between agencies managing the catchment. • Ensure stabilisation of soil excavated during construction of water points to prevent turbid runoff into watercourses.
Wildfires	The risks associated with extensive burning by wildfire and emergency construction of firebreaks are: <ul style="list-style-type: none"> • Erosion and turbidity; • Carbon and nutrient contamination. 	High Low	Intense wildfire can cause turbidity from the ash made airborne during the burn or through runoff when the burn is followed by rain. WC staff attend fires. The fuel reduction burning program run by CALM should reduce the incidence of wildfire.	<ul style="list-style-type: none"> • Where location, extent or intensity of a fire suggests the need, inspect sites following fire to assess the need for turbidity mitigation works, and conduct these works if necessary. • Ensure sites that need permanent protection from wildfire have adequate firebreaks and/or low vegetation buffer zones to prevent the need for extensive earthworks or clearing during a fire. • Emergency firebreaks should be immediately rehabilitated. • For water quality considerations to be sufficiently addressed, a WC staff member should continue to attend all fires in the catchment. • Reduce fuel loads with appropriate prescribed burning by CALM.

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<i>State Forest</i>				
Vehicle roads and tracks	<p>The risks associated with the use of roads and tracks include:</p> <ul style="list-style-type: none"> • Turbidity from erosion of unsealed roads and tracks; • Fuel and chemical spills from vehicles and machinery; • Pathogen contamination from access to the water body. 	<p>High</p> <p>Low</p> <p>Low</p>	<p>Some roads and tracks are necessary for forest management. It is essential they be well maintained to minimise the risk of erosion. Designated roads and tracks in State Forest are public roads, which significantly increases access to the catchment.</p> <p>Vehicle movement is limited in approximately three-quarters of the catchment due to boom gates and signs put in place by Alcoa. When Alcoa finish mining in this area, they will remove all signs and boom gates and control will revert back to CALM and WC.</p> <p>The road verges in this catchment are very steep and runoff carries suspended sediment to the dam, increasing turbidity. Soaks have been dug at strategic locations along some roadsides. These have been effective in reducing turbidity but not eliminating it. Hay bales staked at strategic locations have proven very effective in preventing a significant amount of sediment from reaching the streams. Ideally, these bales should be replaced when full (approximately once or twice per year), however this has not been happening in practice and the resulting channelling of flow adds to erosion.</p>	<p><i>Accepted as necessary for proper forest management and requires best management practices.</i></p> <ul style="list-style-type: none"> • Adhere to DoE's draft Water Quality Protection Note <i>Roads in Sensitive Environments</i>. • Review the road network to identify roads not essential for forest operations and management or transport thoroughfare. • Rehabilitate tracks that are not required for forest operations or transport thoroughfare. • Define 'Public Road' and educate the public on the definition and implication of by-law enforcement. • Ensure an operative emergency response procedure exists and that the Shire of Murray Local Emergency Management Committee is aware of PDWSA boundaries. • Use signs along roads to inform people of their presence in a PDWSA, and display the emergency contact number for use in the event of a spill. • Avoid the development of new tracks and roads through the catchment, particularly within the RPZ.

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<i>State Forest</i>				
Vehicle roads and tracks (<i>continued</i>)			The main unsealed roads that intersect the catchment are Del Park Road and Torrens Road. These roads are major haulage routes. There is some erosion associated with these gravel roads. Due to the mining in the area, traffic along Del Park Road carries a significant amount of fuel and explosives and hence poses a risk in the event of a spill. Torrens Road has very little traffic, as Alcoa have blocked it off east of the Conjurunup Creek crossing. Most runoff from the road is diverted to the nearest streamline.	
<p>Feral animal control</p> <ul style="list-style-type: none"> • Feral pigs • Licensed pig hunters • Foxes <p>(Rabbits and cats are also present but are not perceived to pose a significant water quality problem)</p>	<p>Feral pigs create a large risk of:</p> <ul style="list-style-type: none"> • Turbidity; • Pathogens through excretion of faecal material whilst wallowing. <p>Fox control occurs through baiting and involves a risk of pathogen contamination from animal carcasses.</p>	<p>Medium High</p> <p>Low</p>	<p>Under <i>MWSSD Act</i> by-laws shooting, trapping or hunting of game is prohibited in catchment areas, as is the presence of dogs.</p> <p>Illegal introduction of pigs (and their associated diseases) by hunters is known to have occurred and increases all risks associated with the animals. Feral animal control reduces the risk, but may introduce additional risks to water quality if not properly managed. It is essential that feral pig control, in particular, be undertaken in a well-managed and organised manner in order to minimise the potential impacts on water quality.</p> <p>Feral pig control occurs through volunteer hunters and local landowners, which involves additional risks associated with pathogen contamination from feral animal carcasses and from people and dogs in the catchment.</p>	<p><i>Acceptable activity with controls.</i></p> <ul style="list-style-type: none"> • Ensure feral pig control is performed by the 'trap and shoot' method only, without the use of dogs. • Ensure pig carcasses are removed from the catchment. • Ensure fox baiting is undertaken in accordance with CALM's current 1080 policy <i>CALM Fox Control Manual</i> (CALM, 1996) and <i>Code of Practice on the Safe Use and Management of 1080</i> (DoH, 2000)

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<i>State Forest</i>				
Feral animal control (continued)			<p>WC currently undertakes some feral pig control in the catchment, using the 'trap and shoot' method. This method significantly reduces the risks to water quality as animal carcasses can be easily removed from the catchment.</p> <p>The bait used for fox control contains 1080 (sodium monofluoroacetate), which is a naturally occurring chemical found in the plant genus <i>Gastrolobium</i>. It does not pose a risk to public drinking water supplies as it is rapidly and naturally broken down in the environment by microbial action. Protocol followed by CALM is to ensure baits are not placed within 100 m of the full supply level of drinking water reservoirs.</p>	
<p>Private resource harvesting:</p> <ul style="list-style-type: none"> • Apiaries (4) • Wildflower picking • Seed collection 	<p>The potential risks to water quality from private resource harvesting include:</p> <ul style="list-style-type: none"> • Pathogen contamination through the presence of people near the reservoir and its tributaries; • Increased turbidity due to the use of unsealed roads. 	<p>Low</p> <p>Low</p>	<p>The primary concern is the potential for people to be in close proximity to the reservoir or its tributaries.</p> <p>CALM licenses a number of private wildflower pickers and seed collectors. The permit conditions imposed by CALM for apiarists, private seed collectors and wildflower pickers cater for water quality protection in PDWSAs.</p> <p>There are 4 apiary sites in the catchment, however the sites are not currently in use. The low number of people involved, together with management controls, reduces the associated risk.</p> <p>The low quality of the vegetation in this area reduces the activity in this catchment.</p>	<p><i>Acceptable activity with conditions.</i></p> <ul style="list-style-type: none"> • Ensure that if water is required at apiary sites it is not sourced from the reservoir but trucked in as per licence conditions. • Apply a condition of approval for apiarists, wildflower picking and seed collection licences that requires adherence to water quality protection objectives, including exclusion from the RPZ and no camping in the catchment area. • Inspect water quality protection measures on site.

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<i>State Forest</i>				
Firewood collection	<p>The risks associated with firewood collection include:</p> <ul style="list-style-type: none"> • Pathogen contamination through the presence of people and domestic animals near watercourses; • Rubbish dumping; • Turbidity from the use of unsealed roads and damage to vegetation during off-road driving. 	<p>Medium</p> <p>Low</p> <p>Medium</p>	<p>The primary concern is the potential for people to be in close proximity to the reservoir or tributaries during public firewood collection.</p> <p>Firewood collection is not permitted in the RPZ. The collection of firewood is managed by CALM through a permit system.</p> <p>Rubbish dumping is often associated with public firewood collection points.</p> <p>Domestic animals often accompany people during firewood collection.</p>	<p><i>Acceptable activity with conditions.</i></p> <ul style="list-style-type: none"> • Ensure regional plans for public firewood collection areas give consideration to water quality protection objectives. • Promote firewood collection sites outside the catchment. • Where public firewood areas are required within the catchment, establish designated public firewood areas outside the RPZ, away from the reservoir and its tributaries. • Ensure public firewood areas are regularly patrolled and dumped rubbish is removed. • Use signs and brochures to promote water catchment awareness and to ensure that the public are aware that dogs are not permitted in the catchment, unless on private property. • Undertake surveillance with by-law enforcement.
Research projects	<p>The use of the catchment and reservoir for research projects involves a potential risk of pathogen contamination from people remaining in the catchment, particularly close to or on the reservoir.</p>	<p>Low</p>	<p>The risk associated with this activity is minimal, due to the low numbers of people involved and the ease of education prior to the activity occurring. Projects are frequently supervised by WC staff and Alcoa.</p>	<p><i>Acceptable activity with conditions.</i></p> <ul style="list-style-type: none"> • Ensure education on water quality protection is undertaken prior to the activity. • Apply a condition of approval that requires adherence to water quality objectives.

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<i>State Forest</i>				
Gravel pit	<p>The potential risks associated with the use and maintenance of gravel pits include:</p> <ul style="list-style-type: none"> Increased turbidity from gravel extraction and cleared areas; Fuel and chemical spills from vehicles and machinery; Pathogens from human presence, particularly as gravel pits often attract illegal recreation; Rubbish dumping, often in the form of car bodies, associated with the illegal recreation. 	Medium	<p>Gravel pits used for road maintenance require effective site management to reduce the risks to water quality.</p>	<p><i>Acceptable activity with best management practices.</i></p> <ul style="list-style-type: none"> Approval of gravel extraction proposals should include the conditions stated in DoE's Water Quality Protection Note <i>Extractive Industries within Public Drinking Water Source Areas</i>. Ensure gravel extraction occurs in accordance with Policy Statement No. 2 <i>Local Government Authority Access to Basic Raw Materials from State Forest and Timber Reserves</i> (CALM, 1993), Policy Statement No. 10 <i>Rehabilitation of Disturbed Land</i> (CALM, 1986), and <i>Code of Practice for Timber Plantations in Western Australia</i> (CALM, 1997). Ensure rehabilitation is undertaken immediately after site closure. Ensure gravel pits are constructed outside the RPZ. Inspect water quality protection measures on site. Ensure contract specifications recognise water quality protection objectives.
		Low	<p>Gravel pits are focal points for illegal and sometimes destructive recreational activities usually involving vehicles. Recreational activities may also be responsible for the failure of rehabilitation in gravel pits.</p>	
		Low	<p>Any new pits established by CALM are rehabilitated after use, in accordance with the <i>Code of Practice for Timber Plantations</i> (CALM, 1997) and Policy Statement No. 10 <i>Rehabilitation of Disturbed Land</i> (CALM, 1986).</p>	
		Low	<p>Gravel extraction occurs in accordance with Policy Statement No. 2 <i>Local Government Authority Access to Basic Raw Materials from State Forest and Timber Reserves</i> (CALM, 1993).</p>	
<i>Recreation</i>				
All recreational activities within the catchment are to comply with DoE's Statewide Policy No. 13 <i>Policy and Recreation within Public Drinking Water Source Areas on Crown Land</i> (2003).				
Swimming	<p>There is a high risk of pathogen contamination associated with swimming, through direct body contact with the water body</p>	Medium	<p>Swimming, bathing, bodily contact with water and washing clothes in the reservoir, its tributaries and the RPZ are prohibited under <i>MWSSD</i> by-laws because of the immediate risk to drinking water quality.</p>	<p><i>Swimming is prohibited in the reservoir and its tributaries in the catchment.</i></p> <ul style="list-style-type: none"> Use signs and promotional material to ensure the public are aware that swimming is prohibited in the reservoir and its tributaries. Undertake after-hours surveillance with by-law enforcement.

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<i>Recreation</i>				
Picnicking • Undesignated	The potential risks to water quality from picnicking are: <ul style="list-style-type: none"> • Pathogen contamination; • Rubbish dumping. 	Medium Low	The risk of contamination is increased by proximity to the reservoir, which is generally a desirable aspect of a picnic site. The risk is minimal, as very little area around the dam is accessible.	<i>Picnicking is only acceptable at designated picnic sites.</i> <ul style="list-style-type: none"> • Use signs and brochures to educate visitors on the importance of protecting drinking water quality. • Enforce <i>MWSSD Act</i> by-laws that prohibit undesignated picnicking within the catchment.
Off-road driving (away from designated roads) • 4WDs • Motorcycles • Unlicensed vehicles	The risks associated with off-road driving include: <ul style="list-style-type: none"> • Turbidity from erosion of unsealed roads and tracks, particularly on the steep slopes close to the reservoir and from damage to the vegetation; • Hydrocarbon contamination from fuel spills; • Contamination from vehicle dumping. 	Medium Low Low	Under <i>MWSSD Act</i> By-law 4.7.2: No person shall drive a vehicle on any part of a catchment area other than a road or track which has a graded, gravelled, sealed, primed or other prepared surface without written approval from DoE. Off-road driving occurs extensively in the catchment, particularly amongst motorcyclists and drivers of unlicensed cars. The principal risk associated with this activity is turbidity caused by erosion of unsealed roads and tracks.	<i>Off-road driving (away from designated roads) is not acceptable in the catchment.</i> <ul style="list-style-type: none"> • Review the road network. Close and rehabilitate tracks not essential for forest management or mining operations. • Use signs to advertise that off-road driving away from designated roads is prohibited in the catchment. • Undertake surveillance with by-law enforcement.
Camping • Undesignated camping	The potential risks associated with camping are: <ul style="list-style-type: none"> • Pathogen contamination; • Rubbish dumping. 	Medium Low	Under <i>MWSSD Act</i> by-laws, camping at undesignated campsites in the catchment is prohibited. Undesignated camping poses a significant risk to water quality, as appropriate facilities are not available and sites are generally close to the reservoir or its tributaries. Camping is also likely to involve additional risks associated with illegal activities, such as rubbish dumping, fishing and marroning. There is significantly less camping within Conjurunup Creek catchment than other metropolitan catchments due to mining activities.	<i>Camping is prohibited in the catchment.</i> <ul style="list-style-type: none"> • Use signs and advertising material to ensure the public are aware that camping is prohibited in the catchment, and to educate the public on the importance of protecting drinking water quality. • Undertake surveillance of the catchment with by-law enforcement. • Consider alternate enforcement options under the <i>Environmental Protection Act 1986</i> (i.e. Environmental Protection Policy).

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<i>Recreation</i>				
Bushwalking and cycling <ul style="list-style-type: none"> • Munda Biddi Trail • Informal activities 	The potential risks associated with these activities are: <ul style="list-style-type: none"> • Pathogen contamination from people in the catchment; • Turbidity, primarily from cyclists; • Rubbish dumping. 	Medium Low Low	Cycling along designated tracks (such as the Munda Biddi Trail) can be managed through education, which reduces the risk to water quality. It is essential that designated tracks be regularly inspected and maintained to minimise the risk of degradation and erosion. CALM is responsible for the establishment of the Munda Biddi Trail, which is promoted as a self-guided cycle trail, thus public use is largely informal. Public drinking water catchment protection objectives are mentioned in CALM information brochures. <p>The Bibbulmun Track previously went through the catchment before it was diverted east in 1990, however the old track is still used.</p>	<i>Acceptable activity with conditions.</i> <ul style="list-style-type: none"> • No further trails to be developed in the catchment without consultation with the relevant agencies (CALM, DoE & WC). • Ensure an environmental management plan is developed, implemented and audited for the Munda Biddi Trail, which addresses water quality protection objectives, such as regular inspections and maintenance of the trail. • Use signs and brochures to educate on the <i>MWSSD Act</i> by-laws and the importance of protecting drinking water quality. • Consider alternate enforcement options under the <i>Environmental Protection Act 1986</i> (i.e. Environmental Protection Policy).
Recreational hunting	The major risk to water quality associated with hunting is pathogen contamination from: <ul style="list-style-type: none"> • Feral animal carcasses; • People and dogs in the catchment. 	Medium Medium	Under <i>MWSSD Act</i> By-law 4.3.4: No person shall shoot, trap or hunt any game or catch, or attempt to catch, any fish or marron within a catchment area, without specific permission in writing from DoE to which it may attach any conditions that it deems necessary. <p>CALM approve hunting in the catchment for feral animal control. WC will only approve feral animal control by the 'trap-and-shoot' method. Uncontrolled hunting and shooting introduces significant additional risks to water quality, particularly due to associated camping and the use of dogs.</p> <p>Surveillance by WC Catchment Rangers currently reduces the occurrence of illegal hunting.</p>	<i>Recreational hunting is prohibited in the catchment.</i> <ul style="list-style-type: none"> • Use signs and advertising material to advertise that recreational hunting is not permitted. • Continue surveillance of the catchment with by-law enforcement. • Any hunting in the catchment is by the 'trap-and-shoot' method only, under authorisation as part of the feral animal control program, which is undertaken in an organised manner to minimise contamination. • Ensure the requirement to remove pig carcasses from the catchment is a condition on hunting permits.

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<i>Recreation</i>				
Fishing and marroning	The major risks to water quality from fishing and marroning are: <ul style="list-style-type: none"> • Pathogen contamination from people close to watercourses and the use of bait; • Turbidity from vehicle use close to the water body. 	High Low	Human or animal contact with the reservoir or its tributaries poses an immediate threat to water quality. There are additional risks associated with fishing and marroning through on-site camping, the presence of dogs close to watercourses and the use of bait. Fishing and marroning in the reservoir and tributaries are prohibited under <i>MWSSD Act</i> by-laws. By-laws are enforced by WC after-hours surveillance, but penalties are small and the activities continue. Preventing these activities is essential to protecting water quality.	<i>Fishing and marroning are prohibited in the reservoir and its tributaries in the catchment.</i> <ul style="list-style-type: none"> • Use signs and advertising material to ensure the public are aware that fishing and marroning are not permitted in the catchment. • Liaise with and advertise through the Department of Fisheries and fishing organisations. • Undertake after-hours surveillance of the catchment with by-law enforcement, with the aim of stopping activities. • Increase the penalties associated with offences under Part 4 of the <i>MWSSD Act</i> by-laws. • Consider alternate enforcement options under the <i>Environmental Protection Act 1986</i> (i.e. Environmental Protection Policy).
Other land uses Infrastructure maintenance • Bridges • Pipelines • Associated roads	The major risks associated with these activities are: <ul style="list-style-type: none"> • Turbidity due to the clearing of vegetation and the use of unsealed roads and tracks by heavy machinery; • Herbicides from weed control; • Hydrocarbon contamination due to fuel spills from vehicles and machinery. 	Medium Low Low	Maintenance is necessary for the operation of the infrastructure. The risks to water quality associated with maintenance need to be managed, particularly in close proximity to watercourses. WRC's Statewide Policy No. 2 <i>Pesticide Use in Public Drinking Water Source Areas</i> should be considered when dealing with weed control. There are restrictions on the use of pesticides in catchment areas, reflected in <i>PSC88 Use of Herbicides in Water Catchment Areas</i> (DoH, 1993). PSC88 is currently being updated. Western Power liaises with WC staff when track maintenance or upgrades occur. The Shire of Murray has a routine program where all roadsides are sprayed for weeds.	<i>Best management practices should be followed for all maintenance in the catchment.</i> <ul style="list-style-type: none"> • Ensure that all responsible agencies and their maintenance contractors are aware of PDWSA locations and that appropriate best management practices are followed. • Ensure responsible agencies adhere to relevant policies.

8 Recommendations

The following recommendations and identified key stakeholders are proposed to help protect the water quality of the Conjurunup Creek Pipehead Dam.

1. The Town Planning Scheme for the Shire of Murray should incorporate the management principles outlined in this Plan, including recognition of the Reservoir Protection Zone and Priority 1 classification assigned to land in the Conjurunup Creek Pipehead Dam Catchment Area. (Shire of Murray)
2. Development and works proposals in the Conjurunup Creek Pipehead Dam Catchment Area that are likely to impact on water quality or are inconsistent with Department of Environment's guidelines and Water Quality Protection Notes, including *Land use compatibility in Public Drinking Water Source Areas* (as amended from time to time), should be forwarded to the Department of Environment for assessment and recommendation. (Shire of Murray, Department for Planning and Infrastructure)
3. Signs should be erected and maintained along the boundaries of the Conjurunup Creek Pipehead Dam Catchment Area and Reservoir Protection Zone to define the areas and to promote public awareness of the importance of protecting drinking water quality. (Water Corporation)
4. The Department of Conservation and Land Management, Forest Products Commission, Alcoa World Alumina Australia, Shire of Murray and Department for Planning and Infrastructure should be supplied with a digital copy of the Reservoir Protection Zone and priority classification to facilitate their planning processes. (Department of Environment).
5. The catchment surveillance program and associated by-law enforcement should continue to be implemented by the Water Corporation in the Conjurunup Creek Pipehead Dam Catchment Area. (Water Corporation)
6. Investigate the options for Water Corporation Catchment Rangers and Department of Conservation and Land Management Rangers to be trained to enforce *Metropolitan Water Supply, Sewerage and Drainage Act* by-laws. (Water Corporation, Department of Conservation and Land Management).
7. New recreational events or activities in the catchment should only be approved if in accordance with the requirements of the relevant agencies and Statewide Policy No. 13 *Policy and Guidelines for Recreation within Public Drinking Water Source Areas on Crown Land*. The Department of Environment will not support new activities within the Reservoir Protection Zone. (Shire of Murray, Department of Conservation and Land Management, Water Corporation, Department of Environment)
8. A risk assessment of the Munda Biddi Trail should be completed and the risks addressed. Management plans covering the roles and responsibilities of the relevant agency stakeholders should be prepared and audited. (Department of Conservation and Land Management, Munda Biddi Trail Foundation)
9. Personnel dealing with WESTPLAN – HAZMAT incidents in the area should be given ready access to a locality map of the Conjurunup Creek Pipehead Dam Catchment Area and training to understand the potential impacts of spills on the surface water resource. (Department of Environment, Fire and Emergency Services Authority of Western Australia)
10. The strategies detailed in Table 1 *Land use, potential water quality risks and recommended strategies* should be considered for adoption by those with responsibility for the recommended protection strategy. (Stakeholders)

11. The Department of Environment is to work with the Department of Conservation and Land Management and the Forest Products Commission to update forestry manuals, codes and guidelines. (Department of Environment, Department of Conservation and Land Management, Forest Products Commission).
12. An 'Implementation Strategy' should be prepared for this Plan by the Department of Environment involving all relevant stakeholders. (Department of Environment)
13. Implementation of these recommendations should be reviewed periodically after this Plan is endorsed. A full review of this Plan should be undertaken after five years. (Department of Environment)

9 Glossary

Aesthetic Guideline Level	ADWG level ascribed for acceptable aesthetic quality of drinking water.
Allocation	The quantity of surface water permitted to be abstracted by a licence, usually specified in gigalitres/year (GL/a).
Catchment	The area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater.
Effluent	The liquid, solid or gaseous wastes discharged by a process, treated or untreated.
Health Guideline Level	ADWG level ascribed for acceptable drinking water quality for human health.
IWSS	The Integrated Water Supply System provides water to Perth, Mandurah, Pinjarra, Harvey and the Goldfields and Agricultural regions, servicing approximately 1.5 million people. 50% of the water is from surface water catchments, 50% is from groundwater. Refer to Figure 1 in Water Corporation's <i>Perth's Water Balance – The Way Forward</i> for a diagrammatic representation.
Leaching / leachate	The process by which materials such as organic matter and mineral salts are washed out of a layer of soil or dumped material by being dissolved or suspended in percolating rainwater; the material washed out is known as leachate. Leachate can pollute groundwater and waterways.
m AHD	Australian Height Datum. Height in metres above Mean Sea Level +0.026 m at Fremantle.
Nutrients	Minerals dissolved in water, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorus (phosphate) which provide nutrition (food) for plant growth. Total nutrient levels include the inorganic forms of an element plus any bound in organic molecules.
PDWSA	Public Drinking Water Source Areas are Underground Water Pollution Control Areas, Catchment Areas or Water Reserves established under the <i>MWSSD Act</i> or <i>1909 CAWS Act 1947</i> .
Pesticides	Collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms.
Pollution	Water pollution occurs when waste products or other substances, e.g. effluent, litter, refuse, sewage or contaminated runoff, change the physical, chemical, biological or thermal properties of the water, adversely affecting water quality, living species and beneficial uses.
Runoff	Water that flows over the surface from a catchment area, including streams.
Treatment	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes including drinking and discharge to the environment.
Water quality	The physical, chemical and biological measures of water.

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Acronyms

Alcoa	Alcoa World Alumina Australia
ADWG	Australian Drinking Water Guidelines
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
CALM	Department of Conservation and Land Management
CAWS Act	<i>Country Areas Water Supply Act 1947</i>
DoE	Department of Environment, formerly the Water and Rivers Commission and the Department of Environmental Protection
DoH	Department of Health
DoIR	Department of Industry and Resources
DWSPA	Drinking Water Source Protection Assessment
DWSPP	Drinking Water Source Protection Plan
FPC	Forest Products Commission
GL	Gigalitre; 1 thousand million litres
HAZMAT	Hazardous materials
IWSS	Integrated Water Supply System
ML	Megalitres; 1 million litres.
MMPLG	Mining and Management Program Liaison Group
MOG	Mining Operations Group
MWSSD Act	<i>Metropolitan Water Supply, Sewerage and Drainage Act 1909</i>
NHMRC	National Health and Medical Research Council
NTU	Nephelometric Turbidity Units
P1	Priority 1 - priority classification for land use
PDWSA	Public Drinking Water Source Area
PZ	Prohibited Zone (also known as Reservoir Protection Zone {RPZ})
RIWI Act	<i>Rights in Water and Irrigation Act 1914</i>
RPZ	Reservoir Protection Zone (also known as Prohibited Zone {PZ})
TCU	True Colour Units
WAWA	Western Australia Water Authority
WC	Water Corporation
WHO	World Health Organisation
WRC	Water and Rivers Commission

Appendix 1 - Protecting our Public Drinking Water Source Areas

PROTECTING PUBLIC DRINKING WATER SOURCE AREAS

Introduction

This agency is the custodian of all of the State's water resources. Our role is to ensure the State's water resources are managed to support sustainable development and conservation of the environment for the long-term benefit of the community.

Next to food, water is the most essential element for life, and our aim is to protect Public Drinking Water Source Areas (PDWSA). Achieving this aim will provide consumers with reliably 'safe, good quality drinking water' to protect public health for now and into the future at a reasonable cost to consumers.

This note provides an overview of policy and processes used to protect PDWSA supplying drinking water to major population centres in Western Australia. Generally, private sources supplying drinking water to a household, business or remote aboriginal community are not subject to the same level of assessment, sampling, treatment and reporting requirements. Accordingly, they are not directly addressed in this protection note. Nonetheless, the approaches described in this note are still recommended for private sources. For example, the Water Corporation have a number of significant private drinking water source areas (eg 'roaded' catchments) that they operate consistent with PDWSA policy and processes.

The former State Government agencies the *Department of Environmental Protection* and *Water and Rivers Commission* are presently being combined to form the *Department of Environment*. This process will not be complete until enabling legislation has been passed by Parliament and proclaimed. This note aims to present a generic 'combined agency' position on the nominated topic.

Who is involved in protecting our drinking water supplies?

Responsibility for the condition (quality) and availability (quantity) of our drinking water must be shared by the community, land owners/developers, industry, agriculture, local government, water service providers and the State government. All of these groups play a significant role in the development of Drinking Water Source Protection Plans (DWSPP) for PDWSAs (also called drinking water catchments in this note). They also may be involved in the implementation of the recommendations in those plans. Their direct and ongoing involvement in the protection of our drinking water catchments is essential to achieve a successful outcome.

The Department of Environment (DOE), is primarily responsible for defining, proclaiming and protecting the catchments of Public Drinking Water Source Areas (PDWSAs). The PDWSAs are made up of any area proclaimed to protect public drinking water source catchments. These areas are proclaimed as Water Reserves, Catchment Areas or Underground Water Pollution Control Areas under the *Metropolitan Water Supply, Sewerage and Drainage Act 1909*, and Water Reserves or Catchment Areas under the *Country Areas Water Supply Act 1947*.

The DOE has responsibility to administer the State's catchment protection legislation. This administration includes:

- undertaking and facilitating effective by-law enforcement and catchment surveillance;
- the assessment and permitting of land use developments or activities;
- negotiating protection mechanisms in the land use planning process; and
- advising on the compatibility of land development and use activities.

The DOE also has responsibility for preparing policies and guidelines, drinking water source protection assessments and plans and advising other decision-making agencies on source protection requirements. The Department promotes a coordinated approach to catchment protection encompassing a variety of related measures including regional and local land use planning; health; and environmental legislation.

Where public health is concerned, the Department of Health has primary responsibility. The Department of Health's role is to minimise human exposure to environmental health hazards that pose or have the potential to pose a health risk and to reduce the incidents and impact of communicable disease. To safeguard against unhealthy drinking water, the Department of Health works closely with the DOE and individual Water Service Providers. The Department of Health also chairs an inter-agency committee, called the "*Advisory Committee for the Purity of Water*", established in 1925 and charged with the ongoing responsibility of advising the State on drinking water protection issues. The Office of Water Regulation is another government agency with a key role in regulating drinking water supply issues. It issues licences to individual Water Service Providers such as the Water Corporation, Aqwest (Bunbury) and Busselton Water Board.

The Water Corporation is the largest Water Service Provider in WA, and it was formed in the mid 1990's after the split of the former Water Authority of Western Australia as part of the COAG Water Industry Reform initiatives. The Corporation is the major licensed Water Service Provider in Western Australia, supplying the Perth metropolitan area as well as a further 230 towns across the State. It is a corporation, with the state government being the sole shareholder, and is subject to corporation law. It is managed by a board of directors including the Managing Director (its CEO). The Corporation is required to return a dividend on the Government's investment in the Corporation's assets and in return receives Customer Service Obligation (CSO) payments to subsidise uneconomic services that are required to be provided by the Government. The Corporation also pays federal tax equivalents to the State Government in accordance with the COAG reform agreement.

Source Protection Operational Agreements exist between the DOE and the Water Corporation, which assign roles in catchment protection, clarify responsibilities in catchment protection and ensure the process is carried out effectively. Under the legislation, the DOE may delegate certain catchment management functions to the Water Corporation (or other water service providers). Delegation is appropriate as the Corporation has a strong vested interest in assuring high quality drinking water from the catchments and is also prepared to resource catchment management functions. Currently, delegated functions relate to catchment surveillance, enforcing by-laws regarding transient catchment activities, entry onto land and catchment management planning. The extent of delegated responsibilities may vary between catchments.

Why should we protect our drinking water supplies?

Drinking water should be safe to drink and aesthetically pleasing. Ideally, it should be clear, colourless, pleasant tasting and contain no harmful chemicals or disease-causing microbes. To keep drinking water clean it is important to protect both our surface and underground drinking water sources (e.g. surface dams and groundwater) and the catchments in which they are located.

This advice deals with the water consumed in homes and provided by licensed Water Service Providers (often referred to as 'scheme' supplies). These WSP are responsible for water treatment (including disinfection) and distribution services to the community. Advice on alternative (potentially less safe) drinking water sources, such as private bores or rainwater tanks, is available in other documents. As a rule neither the Department of Health or DOE recommend the use of rainwater or private bore water for drinking water purposes where a scheme water source is available. This is because the catchments of these other sources are generally not protected from contamination and they are not analysed or treated to meet the relevant health guidelines for drinking water. Such sources can however be useful for non-potable uses such as in washing machines, toilets or for gardens. If a scheme supply is not available, then it is important that the consumer implements the necessary measures to ensure their drinking water source is safe to drink (i.e. arrange water analyses and treatment as required).

In the mid 1990's, the Council of Australian Government reforms process took an initiative to pursue the sustainable use of water resources by protecting and enhancing their quality, while maintaining economic and social development. This was achieved through the development of a National Water Quality Management Strategy (NWQMS) presently comprising 21 national guideline documents. Two of these focused on drinking water, the *Australian Drinking Water Guidelines-Summary and the Australian Drinking Water Guidelines*, 1996 (an update of the 1987 *Guidelines for Drinking Water Quality in Australia*). The *Australian Drinking Water Guidelines*, 1996 (ADWG) recognised water source protection through catchment management as an effective approach to preventing contamination of drinking water sources and undertook to investigate this issue further.

In May 2001, Western Australia supported the NWQMS (including the ADWG) through the launch of its own State Water Quality Management Strategy (SWQMS). In late 2002, the ADWG were updated and released for public comment. The ADWG 2003 have now been finalised and are planned to be released in late 2003. A 'consumer guide' to the ADWG 2003 called *Water made clear* has also been developed to raise awareness of the need to protect drinking water catchments from 'catchment to consumer'.

Roughly half of Perth's water supplies come from surface sources with the remainder harvested from groundwater. In 1994, a Parliamentary Select Committee reported on the issue of Perth's development and groundwater supplies. The Select Committee considered experience from around the world and overwhelmingly concluded, "an ounce of prevention is worth a pound of cure". In his foreword, the chairman of the Select Committee noted: "*experts around the world expressed their envy of our relatively pristine water supply and advised us to protect our groundwater supply at all costs*".

In 2000, the State Legislative Council's *Standing Committee on Ecologically Sustainable Development in relation to the Quality of Perth's Water Supply* expressed confidence in the system managing and operating Perth's water supply. The Standing Committee noted, however, that various activities posed a contamination risk to water supplies. It found as a "*first priority that water sources be protected through good land use planning. It also noted that "Using treatment to deal with contamination is a second-best option. The Committee found support for adopting catchment protection as the major weapon in preventing contamination of water supplies*". In November 2001, in support of this finding, the Western Australian Planning Commission (in consultation with the Water and Rivers Commission) released a *Public Drinking Water Source Policy* for public comment. The Policy was gazetted in June 2003. This policy will guide State and Local Government land use planning decisions in public drinking water catchments.

Although the above committees were reporting on Perth's water supplies, their findings apply to all public drinking water sources in Western Australia. This is especially true when a community is reliant upon a single drinking water resource (such as the groundwater bore network in Kununurra or surface water dam in Quinninup) rather than an integrated series of sources (such as those that supply Perth). Contamination

of a single resource from inappropriate land use planning or polluting activities within the catchment can have significant health and economic impacts, which should be avoided.

In February 2003, the Western Australian Government released its State-wide water strategy. Although prepared in response to a number of forums around State focusing on drought, it did however make a significant statement about protecting our public drinking water sources. It stated unequivocally that *recognition of the primacy of water quality in the management of drinking water catchments, to protect the long term sustainability of the resource, will be used to guide catchment management decisions.*

This is interpreted to mean, when managing and protecting any public drinking water source catchment, the dominant consideration must be maintenance of water resource quality and the prevention of contamination risk. This objective in most cases may prevent or constrain further land development.

More recently in September 2003, the Western Australian Government also released its State-sustainability strategy document – “Hope for the future”. Drinking water catchments are now recognised as important ‘natural resources’ together with the other more common natural resources (eg. agriculture, fisheries, forestry, mining, tourism, aquatic systems, coastal and marine environments and rangelands). The ‘Vision’ in the Strategy is that “Drinking water sources are fully protected for future generations.”. The Strategy lists the following ‘Actions’: (number 3.48) that we “Work to ensure all present and future drinking water sources are protected.”; and (number 3.51) that we “Ensure the activities in catchments are actively managed and sustainable...” through “...investigation of the impact of active catchment management strategies that enhance water quality and quantity outcomes...”.

What are we protecting the drinking water supplies from?

Land use planning decisions and recreational or business activities occurring in drinking water catchments can impact on the quality and quantity of drinking water. Where catchments remain covered with native vegetation with little human activity, the risk of contamination is low. However, contamination risks increase with increased human activity.

Potential contaminants may include:

- physical contaminants e.g. colour, foaming agents and suspended solids;
- chemical contaminants e.g. salts, heavy metals and poisons; or
- microbiological contaminants e.g. bacteria, protozoa and pathogenic viruses.

Although many contaminants can be removed by treatment processes, such treatment increases the cost of the water supply, and continuous effective removal of all contaminants is not considered technically or economically feasible. If contamination does occur, the opportunity to locate and develop a replacement source is often limited, and the provision of alternatives, e.g. bottled drinking water, is costly and can only be considered a short-term solution. Stopping contamination before it occurs prevents the need for costly treatment or the development of often more costly alternative sources. It should also be appreciated that there is a substantial ongoing financial cost to be borne in sampling and testing for contaminants if they become prevalent in drinking water sources. The benefits (environmental, social and economic) of avoiding contamination through best management decisions and practices are recognised in the ADWG 2003.

Clearly drinking water quality and safety cannot be taken for granted. Appropriate State and Local Government controls are required in consultation with, and the support of the community and other stakeholders. These controls are needed to manage a number of threats to drinking water areas, including inappropriate:

- land use planning processes and decisions resulting in high risk developments in catchments;
- recreational activities where the impact of human wastes and damage to natural protective measures associated with higher intensity land use is often underestimated; and
- use and/or disposal of chemicals, animal and domestic wastes and pesticides.

We should also appreciate that beyond the actual catchment and water storage area, drinking water that is not properly treated, or which travels through an inadequately maintained distribution system, also poses a serious public health risk.

Several recent events that have occurred nationally and internationally that highlight the importance of protecting drinking water, especially at the source.

The main finding of an inquiry into the well-publicised Sydney Water Crisis in 1998 was that the catchments were seriously compromised by many possible sources of contamination, and that there was insufficient regulatory control to guarantee safe drinking water. The Sydney Water Catchment Authority was set up in response to this event which transferred responsibility for land use decisions within the catchment from the Planning Authority to the new catchment Authority.

In Walkerton (Canada), in 2000 a drinking water catchment related tragedy unfolded where a pathogenic E-coli outbreak resulted in over 2300 cases of illness amongst 4,800 residents, 70 people were hospitalised and 7 deaths were attributed to the outbreak. A judicial inquiry concluded that the likely initial cause of the outbreak was from manure application on farmland (a common practice even in WA) that resulted in bacterial contamination finding its way into the shallow underground water-body which was used to supply drinking water. Other contributing factors to the outbreak included a high rainfall event just prior to the contamination outbreak, and an inadequate disinfectant dose rate and monitoring issues related to the distribution system. It is important to appreciate that the drinking water system at Walkerton operated for more than 8 years without major incident up until the year 2000. The over-reliance on treatment to provide a safe drinking water supply was highlighted and a new approach adopted that considered both catchment protection and improved treatment (in combination) to provide a more reliably-safe supply to consumers.

How do we protect public drinking water source areas in WA?

A 'catchment to consumer' multiple barrier approach is used in the management of drinking water quality in Western Australia. Catchment management for protection of the water source (held in storage in surface dams or underground aquifers) is considered the first important barrier. Historically, a heavy reliance was placed on treating water to achieve the desired level of safety, but it is now recognised that treatment alone does not remove all hazards to public health. Therefore, to maximise public health safety effective catchment protection is also essential. Other barriers include:

- selection of an appropriate safe high quality source (where alternatives exist);
- controls over land uses and high risk human activities in catchments underpinned by statutory measures;
- protective undeveloped buffer zones to supply bores, reservoirs and feeder streams;
- catchment protection strategies for education, surveillance, enforcement and monitoring/reporting;
- pre-treatment of drinking water, for example use of detention and settling in reservoirs to induce microbes to die off;

- protection of water storage works, for example water tanks and reservoirs;
- disinfection of drinking water before it enters the distribution system and provision to ensure an adequate disinfectant residual throughout that system;
- maintaining the distribution system as a whole including the pipe system, vermin-proofing of water tanks and preventing back-flow; and
- Promotion of source protection measures in local government planning schemes using the WA Planning Commission's *Statement of Planning Policy– Public Drinking Water Source Policy* (June 2003).

A key process employed by this agency to protect drinking water sources involves the preparation of Drinking Water Source Protection Plans (DWSP) for the State's PDWSAs.

Drinking Water Source Protection Plans (and Drinking Water Source Protection Assessments)

Drinking Water Source Protection Plans are a key component of the 'catchment-to-consumer' protection strategy for Western Australia's drinking water supplies. This is reflected in the Government's report "*Securing our water future - A State Water Strategy for Western Australia (2003)*" which states that **water source protection plans should be completed for all public drinking water supply catchments throughout the State**. A DWSP aims to identify existing and potential threats to a drinking water source and to provide risk management strategies and programs for the ongoing management/protection of that source.

Plans are prepared in consultation with the community, potentially affected stakeholders (especially landowners), local government and the State government. Stakeholders are strongly encouraged to consider the risks and potential consequences of inappropriate land-use planning or human activities in the catchment (e.g. contamination of the resource and costs to clean-up or establish a new drinking water source). It should be noted that decisions made following consultation may result in some land use/activity restriction in order to achieve a safe, good quality drinking water supply.

Providing a basis for establishing compatible land uses within PDWSAs, the DWSP is only one of a suite of measures used by this agency to meet its drinking water protection responsibilities. As at June 2003, there were approximately 139 plans listed for completion. Of this number, 50 are complete and 89 are in production.

While the full suite of DWSPs await completion, land planners and developers need to be aware of the location of and risks to existing drinking water catchments. To this end the DOE is preparing Drinking Water Source Protection Assessments (DWSPA). These Assessments will provide a broad overview of catchment risks, planning and land uses; and a basic understanding of the drinking water catchment and supply system. They are not intended to include extensive data, but to characterise the drinking water system by providing useful information for decision makers. Generally, the DWSPA will be a desktop assessment followed by a site visit and discussions with local government. In some circumstances the DWSPA may be all that is required to achieve good land planning/activity controls (e.g. through planning schemes or strategies) for the protection of drinking water source areas. Otherwise, the DWSPA will be considered base information for development of the DWSP described above.

Priority classification system

This agency has also implemented policies to protect public drinking water source areas that includes a differential 'priority classification area' system that includes special 'protection zones' around bores and reservoirs. Through development of a DWSPP (or possibly the DWSPA), land in a PDWSA is identified as a mix of Priority 1 (P1), Priority 2 (P2) or Priority 3 (P3) classification areas, with appropriate protection zones.

Priority 1 (P1) source protection areas are defined to ensure that there is **no degradation** of the water source. P1 areas are declared over land where the provision of high quality public drinking water is the prime beneficial land use. P1 areas would typically include land under public ownership but may in a limited number of cases include private land.

P1 areas are managed in accordance with the principle of **risk avoidance**, and hence land development is generally not permitted. Where P1 land is in private ownership this agency may make an offer to the owner to sell their land at agreed market values subject to available funding and priority order purchasing rules. There is no obligation on the owner to sell their land.

Priority 2 (P2) areas are defined to ensure that there is **no increased risk of pollution** to the water source. P2 areas are declared over land where low intensity development (such as rural) already exists. Protection of public water supply sources is a high priority relative to other land use values in these areas.

P2 areas are managed in accordance with the principle of **risk minimisation**, and as such only limited conditional development is supported. Such development must be consistent with the protection of waters within the drinking water catchment. A proposed change in land use from a relatively low to a more intensive use may result in contamination of the PDWSA, and would not be supported.

Priority 3 (P3) areas are defined where it is practical to **manage the risk of pollution** to the water source, and where water supply sources need to co-exist with other generally existing land uses such as residential, commercial and light industrial developments.

Protection of P3 areas is achieved through **management guidelines** rather than restrictions on land use. Key elements in protection of P3 areas are the provision of deep sewerage and land users using best environmental management practices for their activities. In P3 areas, compared to P1 and P2 areas, it is likely that the direct cost of providing the drinking water to consumers is greater, given the need to monitor and treat the water more comprehensively due to the variety of existing and allowable land uses/risks. If water from P3 areas becomes contaminated, then that water may need to be further treated or an alternative water source found.

In these priority areas there is a strong reliance on landowners, developers, regulators and other users to be acutely aware of the drinking water resource and risks, such that the adoption and implementation of best management practices will help protect the drinking water source. Existing lawfully established but non-conforming land uses in PDWSAs are allowed to continue, however land users will be encouraged to adopt environmentally responsible/best practice land use practices. This agency has prepared a "*Water Quality Protection Note -Land Use Compatibility table in PDWSAs*" that provides guidance on the type of land uses appropriate within P1, P2 and P3 areas.

Reservoir and wellhead protection zones

As noted above, reservoir protection zones (RPZ) are also defined to protect the surface water source from contamination in the immediate vicinity of reservoirs. Reservoir protection zones consist of up to a 2 kilometre buffer around the top water level of a reservoir and includes the reservoir itself. These zones do not extend outside the catchment area (i.e. downstream from a dam wall). This agency provides a high level of protection in these zones and does not support land uses or activities that may add to the risk of contamination of the water source. Generally conditions apply in these zones aimed at preventing people from entering the RPZ to avoid the risk of contamination (consistent with the P1 areas).

For underground water sources, well-head protection zones are defined around the abstraction bores and allowable activities/ land uses in these areas are also restricted and subject to approval processes. Well-head protection zones in P1 areas are set at a 500 metre radius around a bore, and in P2 or P3 areas they are set at a 300 metre radius around a bore.

How are priority classification areas and protection zones determined?

The determination of a priority classification area or protection zone over land in a PDWSA is based on the strategic importance of the land or water source, its zoning, ownership and existing approved land uses/activities. The land use tables in this protection note directly relate to the three types of priority classification areas identified in DWSP or agreed in Land Use and Water Management Strategy documents. In the absence of a DWSP, the DOE recommends that planning decisions within any gazetted or proposed PDWSA are guided by DWSPA documents (where they exist) and the 'potential' priority classification area or protection zone status of a proposal identified using the following process flow diagram.

Conclusion

We can improve the availability of 'safe, good quality drinking water' to protect public health if we continue to combine catchment protection and water treatment approaches. This 'catchment to consumer' approach to drinking water protection is the basis of the recently updated *Australian Drinking Water Guidelines 2003*.

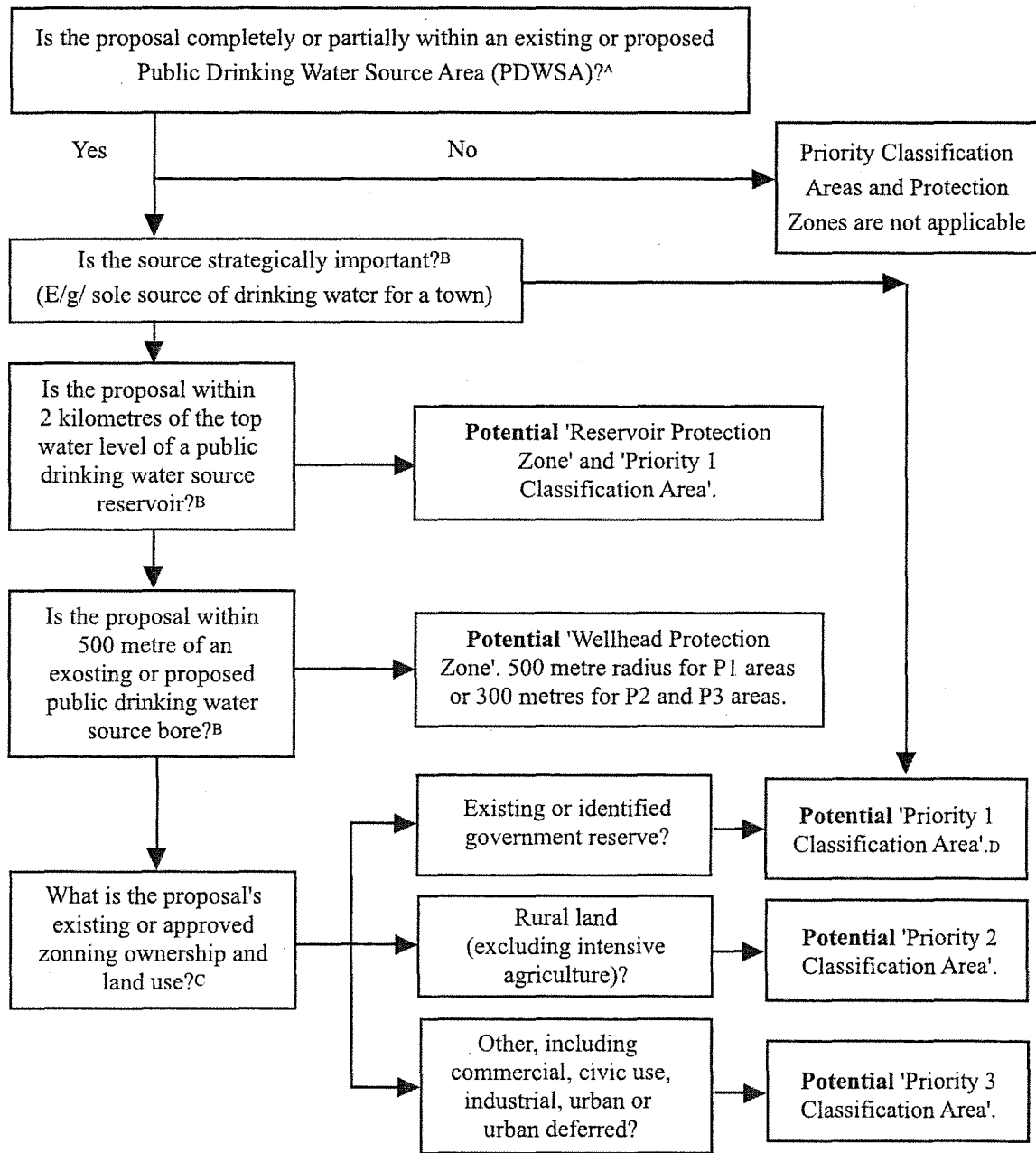
Many land uses and activities can pose a risk to water quality, so in undeveloped drinking water catchments strict management controls are proposed to 'avoid the risk' of contaminating the source. In catchments with some level of development, management controls recognise the existing development but may place restrictions on alternative land uses or expansion of existing land uses. This approach looks to 'minimise' or 'manage the risk' of contamination in the catchment. These management controls help protect public health, lower the costs of supplying drinking water to consumers and provide a long term source of safe, good quality drinking water.

More information

We welcome your thoughts on this note. The note will be updated from time to time as comments are received, or industry standards change.

If you wish to comment on the note or require more information, please contact our Program Manager, Protection Planning (Stephen Watson) at the Water Source Protection Branch in our head office in the Hyatt Centre. Phone: (08) 9278 0454 (business hours), Fax: (08) 9278 0585.

Figure 1. Determination of Priority Classification and Protection Zones



Legend

- A The location of PDWSAs can be found in DOE’s Drinking Water Source Protection Assessments and Plans or through your regional DOE office, Local Government office, Water Corporation or from the Department for Planning and Infrastructure.
- B Strategically significant sources and potential contamination from land uses close to drinking water reservoirs or abstraction bores are considered first, due to these involving the highest risk of contamination reaching consumers.
- C Current zoning or land use information is available from your Local Government office.
- D Government land is protected to achieve the highest level of safety for drinking water in all parts of a catchment through a Priority 1 classification, wherever this is reasonable and practicable.

Appendix 2 - Water quality analysis

WATER QUALITY ANALYSIS RESULTS

Explanatory note

Following storage on site to gain the benefits of natural microbiological improvement, water from Conjurunup Creek Pipehead Dam is disinfected prior to being pumped back to the North Dandalup Pipehead Dam. The Water Corporation is required to comply with the health related guidelines of the Australian Drinking Water Guidelines (ADWG). There were no cases where these guidelines were exceeded. Compliance with the aesthetic water quality guidelines of the ADWG is not required; occasionally these guidelines were exceeded.

Health parameters

Raw water from Conjurunup Creek Pipehead Dam is analysed for health related chemicals. Health related chemicals include inorganics, heavy metals, industrial hydrocarbons and pesticides. Health related water quality parameters that have been measured at detectable levels in the source between July 1999 and July 2004 are summarised in the following table.

Parameter	Units	Health Guideline Value*	Conjurunup Creek Pipehead Dam	
			Range	Median
Metals				
Barium	mg/L	0.7	0.015 – 0.021	0.015
Boron	mg/L	4	<0.02 – 0.02	0.02
Inorganics				
Nitrate + Nitrite (as N)	mg/L	11.3	<0.002 – 0.008	No Detection

* A health guideline value is the concentration or measure of a water quality characteristic that, based on present knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHMRC & ARMCANZ, 1996).

Aesthetic water quality data

Aesthetic water quality analyses of raw water from Conjurunup Creek Pipehead Dam are summarised in the following table. The values are taken from ongoing monitoring for the period July 1999 to July 2004. The values are in milligrams per litre (mg/L) unless stated otherwise. The water quality parameters that have on occasion exceeded the ADWG are shaded.

Parameter	Units	Aesthetic Guideline	Conjurunup Creek Pipehead Dam	
		Value	Range	Median
pH		6.5 – 8.5	6.39 – 7.61	6.87
Turbidity	NTU	5	0 – 4.8	0.45
Colour	TCU	15	3 - 15	6
Conductivity	mS/m	-	19 - 42	25
Total Dissolved Solids	mg/L	500	113 - 224	140
Iron (unfiltered)	mg/L	0.3	0.10 – 0.65	0.16
Manganese (unfiltered)	mg/L	0.1	0.004 – 0.022	0.006
Aluminium (unfiltered)	mg/L	0.2	0.02 – 0.4	0.1
Sodium	mg/L	180	30 – 54	37
Potassium	mg/L	-	0.5 – 1.8	1.4
Calcium	mg/L	-	1.6 - 7	2.6
Magnesium	mg/L	-	3.4 – 7.5	4.4
Hardness (as CaCO ₃)	mg/L	200	18.2 - 49	24
Alkalinity (as HCO ₃)	mg/L	-	4.8 - 31	9.6
Chloride	mg/L	250	54 - 99	65
Sulphate	mg/L	250	6 – 9.5	7
Silica (as SiO ₂)	mg/L	-	4.5 – 7.9	6.6
Filterable organic carbon	mg/L	-	1.4 – 3.8	2.4

Microbiological analysis

Microbiological testing of raw water samples is conducted on a weekly to monthly basis, depending on the season, i.e. more frequent sampling is undertaken during summer and autumn. Thermotolerant coliform counts are used as an indicator of the degree of faecal contamination of the raw water from warm-blooded animals. A count less than 20 colony forming units (cfu) per 100 mL is typically associated with low levels of contamination and is used as a microbiological contamination benchmark (WHO, 1996).

During the review period of July 1999 to July 2004, positive thermotolerant coliform counts were recorded in 90% of samples, with 44% of the positive samples exceeding 20 cfu/100mL.

Appendix 3 - Land use compatibility in Public Drinking Water Source Areas

LAND USE COMPATIBILITY IN PUBLIC DRINKING WATER SOURCE AREAS

Purpose

The Department of Environment (DoE) is responsible for managing and protecting the State's water resources. This note provides advice on the acceptability of land uses and activities within specific catchments that are the water source for schemes supplying cities and towns. These catchments are termed Public Drinking Water Source Areas (PDWSAs) and they require comprehensive water resource quality and land planning protection measures to ensure the ongoing availability of a 'safe, good quality drinking water' supply to protect the health of consumers for now and into the future. This note supports the DoEs Public Drinking Water Resource Policy (July 2004).

The note also forms an integral part of the Western Australian Planning Commission's *Statement of Planning Policy No. 2.7- Public Drinking Water Source Policy 2003* (relevant to approximately 140 existing PDWSAs in Western Australia) prepared by the Department for Planning and Infrastructure under Section 5AA of the *Town Planning and Development Act 1928*. It is also intended to support the proposed Statement of Planning Policy for *Water Resources* designed to guide planning decisions in future PDWSAs. This note should be used by Local Government when developing local planning strategies, structure plans and town planning schemes. It should also be used in the assessment of subdivision and other development applications. The note will also assist the development of formal guidelines on land use activities in PDWSA prepared in liaison with key stakeholders such as the Water Corporation, Department of Health, Department of Conservation and Land Management, Department of Agriculture, Department of Industry and Resources, Department for Planning and Infrastructure and local government.

A review of this note may occur within 12 months (depending on feedback) to reflect DoE's policy position (which is influenced by public consultation undertaken for PDWSAs), advances in technology or land use activity standards, and Government decisions made concerning drinking water quality protection. This note may not consider all the circumstances that exist for planning strategies, plans and schemes across the State. Accordingly, changes to this note will only be considered if they apply broadly across the State. Other means of addressing localised special circumstances may be employed and the DoE will assist in achieving this outcome provided those changes do not place the PDWSA at a higher contamination risk.

Scope

This note provides the DoE's position on a range of land uses assessed against the Department's water quality protection strategy and management objectives within PDWSAs. Where a specific land use has not been covered in the accompanying tables, it should be referred to the Department's Water Source Protection Branch for assessment and a written response concerning its acceptability or any necessary water resource protection measures.

Public Drinking Water Source Area in Western Australia is the collective description for:

- Underground Water Pollution Control Areas,
- Water Reserves, and
- Catchment Areas,

declared under the *Metropolitan Water Supply, Sewerage and Drainage Act 1909* or the *Country Areas Water Supply Act 1947*.

This note is intended to complement the statutory role and policy of State and local government authorities, but it does not override Government policy or the need for proponents to fulfil their legal responsibilities for land use planning, and environmental, health, building or other necessary approvals.

PDWSA protection framework

The protection of PDWSAs relies on statutory measures available in water resource management and land use planning legislation. The DoE policy for the protection of PDWSAs includes three risk management based priority classification areas and two types of protection zones. The priority classification areas and protection zones are determined via specific Drinking Water Source Protection Plans (DWSPP) that are prepared in consultation with State government agencies, landowners, local government, and key industry and community stakeholders. Where a fully consulted DWSPP does not exist for a PDWSA, the DoE initially prepares Drinking Water Source Protection Assessment (DWSPA) documents to reflect readily available information for use in land use planning assessments and decision making.

Priority classification areas

Priority 1 (P1) classification areas are managed to ensure that there is **no degradation** of the drinking water source by preventing the development of potentially harmful activities in these areas. The guiding principle is **risk avoidance**. This is the most stringent priority classification for drinking water sources. P1 areas normally encompass land owned or managed by State agencies, but may include private land that is strategically significant to the protection of the drinking water source (e.g. land immediately adjacent to a reservoir). Most land uses create some risk to water quality and are therefore defined as “**Incompatible**” in P1 areas.

Priority 2 (P2) classification areas are managed to ensure that there is **no increased risk** of water source contamination/ pollution. For P2 areas, the guiding principle is **risk minimisation**. These areas include established low-risk land development (e.g. low intensity rural activity). Some development is allowed within P2 areas for land uses that are defined as either “**Compatible with conditions**” or “**Acceptable**”.

Priority 3 (P3) classification areas are defined to **manage the risk of pollution** to the water source from catchment activities. Protection of P3 areas is mainly achieved through guided or regulated environmental (risk) management for land use activities. P3 areas are declared over land where water supply sources co-exist with other land uses such as residential, commercial and light industrial development. Land uses considered to have significant pollution potential are nonetheless opposed or constrained.

Wellhead and reservoir protection zones

In addition to the three Priority Classification Areas, specific protection zones are defined to protect drinking water sources from contamination in the immediate vicinity of water extraction facilities. Within these zones by-laws may prohibit, restrict or approve defined land uses and activities to prevent water

source contamination or pollution. Special conditions, such as restrictions on storage and use of chemicals, may apply within these zones. The legislation is currently being reviewed to simplify and enhance the protection of public drinking water sources.

Wellhead protection zones (WHPZ) are used to protect underground sources of drinking water. They are circular (unless information is available to determine a different shape), with a radius of 500 metres in P1 areas, and 300 metres in P2 and P3 areas. WHPZ do not extend outside PDWSA boundaries. Reservoir protection zones (or '**prohibited zones**' as they are called in the by-laws) consist of a statutory 2 kilometre wide buffer area around the top water level of storage reservoirs in the Perth water supply area, and include the reservoir water-body. The reservoir protection zones (RPZ) apply over Crown land and prohibit public access to prevent contamination (physical, chemical and biological) of the source water. RPZ do not extend outside PDWSA boundaries. The DoE is currently considering a provision for RPZ buffer areas of less than 2 kilometres, and creation of consistent by-laws for country and Perth PDWSAs.

Special protection measures apply in WHPZ and RPZ (prohibited zones) as described in the By-laws under the *Metropolitan Water Supply, Sewerage and Drainage Act 1909* and the *Country Areas Water Supply Act 1947*.

The determination of priority classification areas or protection zones over land in a PDWSA is based on:

- the strategic importance of the land or water source,
- the local planning scheme zoning,
- form of land tenure, and
- existing approved land uses/activities.

The land use tables in this protection note directly apply to the three types of priority classification areas identified in DWSP or agreed in specific *Land Use and Water Management Strategy* documents. Currently there are 45 DWSPs available to guide land use planning decisions in PDWSAs, and (nearly 100) others are in development. In the absence of a DWSP, the DoE recommends that planning decisions within any gazetted or proposed PDWSA are guided by DWSPA documents (where they exist) and the '**potential**' priority classification area or protection zone status of a proposal identified using **Diagram 1: Assessment of potential priority classification areas and protection zones** (overleaf).

Compatibility of land uses within PDWSAs

The tables in this note have been prepared for use by local governments, State planners and other agencies as a basis for regulating land use within PDWSAs. The note complements the Western Australian Planning Commission's *Statement of Planning Policy Number 2.7 (June 2003) Public Drinking Water Sources*. These tables define land uses in terms of their compatibility with the sustainable use of the drinking water source. They promote a priority for protection of the environmental value: 'drinking water' within a PDWSA over other values that may exist. The three definitions used are '**Incompatible**', '**Compatible with conditions**' and '**Acceptable**'. In previous versions of this note the definitions were 'Incompatible', 'Conditional' and 'Compatible'.

The DoE recognises that there may be special circumstances which may occasionally result in an '**Incompatible**' land use receiving approval. Where planning decisions result in this outcome it is important for project proponents to have demonstrated an overriding community benefit and that the land use will not increase the risk of contamination to the PDWSA. The DoE expects to have significant, early involvement in planning decisions of this nature to maximise the protection of the drinking water resource.

It should be noted that where a water source is the sole supply for a community, or has a particularly high strategic value for the supply of drinking water, then it would be difficult to understand how that source might be put at any risk of contamination.

Detailed information on water quality protection issues and recommended best management practices for '**Compatible with conditions**' land uses are being developed in approved environmental policy, codes of practice, management guidelines and water quality protection notes. These documents, along with the most recent version of this note, can be found on the DoE Internet site <http://www.environment.wa.gov.au>. Information on land use and development regulation within PDWSAs can also be obtained from DoE's regional offices.

The DoE's Water Source Protection Branch, presently located in East Perth, is custodian of this water quality protection note and will provide detailed advice on its application and coordinate any suggested amendments.

Existing approved land uses

Many land uses covered in this note may have been legally established prior to establishment/ gazettal of the PDWSA or modern protection measures being required. The DoE policy is that existing approved land uses/ activities can continue at their presently approved level, provided they operate lawfully. Where necessary, negotiations may be arranged with land owners to acquire property rights in P1 source protection areas. Where practical, this agency will also negotiate with the operators of existing '*Incompatible*', or '*Compatible with conditions*' activities to implement environmental management practices that minimise risks to water sources.

Proposed land uses

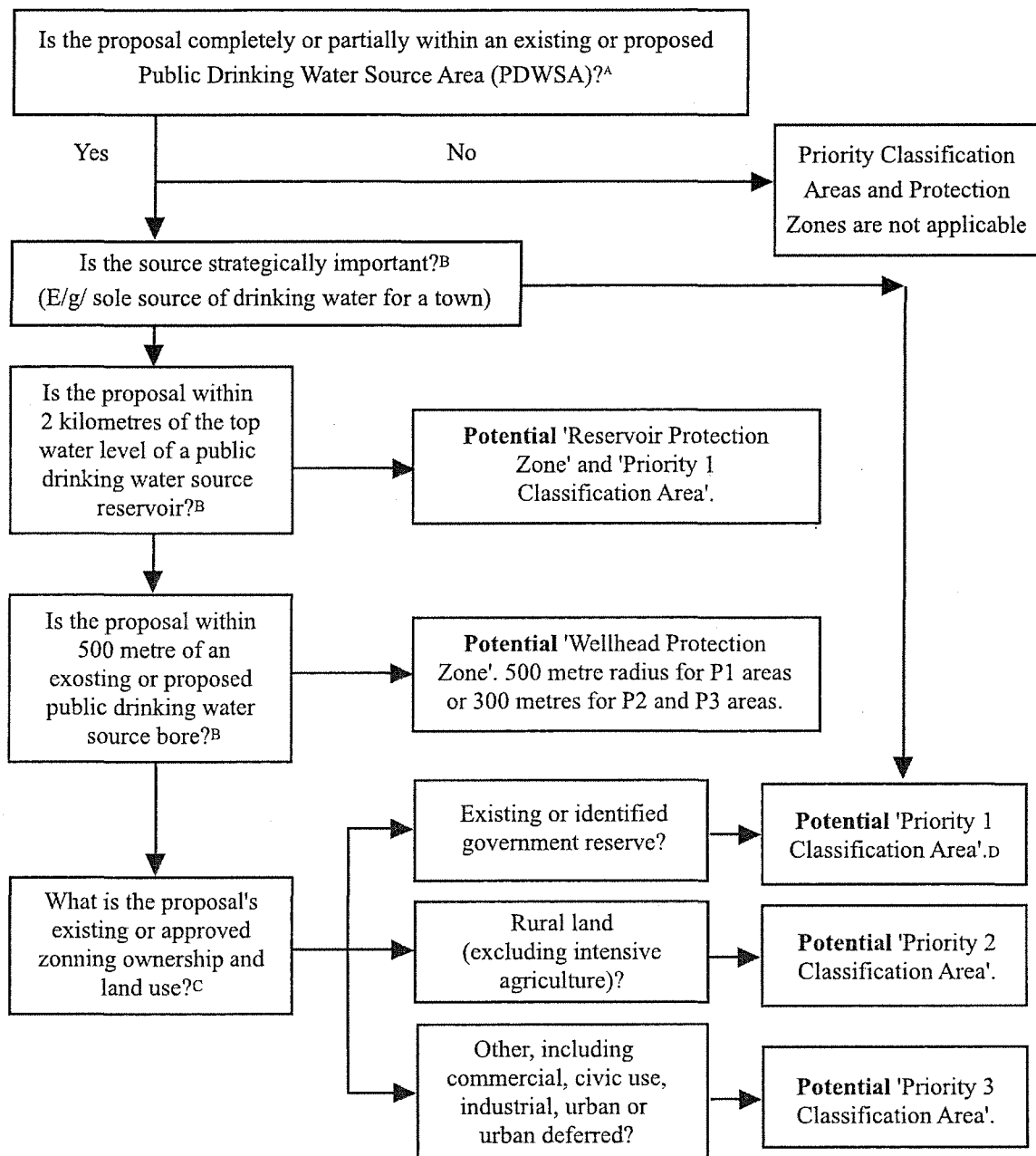
After reading this protection note, please view the DoE Internet site and/ or contact your nearest DoE Regional Office for advice on the location of PDWSAs, priority classification areas, and reservoir or wellhead protection zones. You may discuss with DoE staff any proposed land use activities that may affect water resources. The early identification of water resource protection issues in development stages of land use planning proposals is recommended in both the June 2003 *Statement of Planning Policy for Public Drinking Water Sources* and proposed *Water Resources Policy* by the Western Australian Planning Commission.

Definition of terms used in the following tables

'Acceptable' (equivalent to 'compatible' in previous version of this note)- means the land use is accepted by DoE as not likely to harm the drinking water source, and is consistent with the management objectives of that priority classification. The adoption of best practice environmental management methods for new proposals to protect water quality is expected. Existing land users are also encouraged to adopt best practice environmental management methods to help protect water quality. These land uses generally do not need referral to the DoE.

'Compatible with conditions' (equivalent to 'conditional' in previous version of this note) - means the land use is likely to be accepted by DoE as not likely to harm the drinking water source, (and is consistent with the management objectives of the priority classification) provided best environmental management practices are used. This may result in the application of 'specific conditions' (via the planning or environmental approval processes) that must be complied with to ensure the water quality objective of the priority area is maintained.

Figure 1. Assessment of potential priority classification areas and protection zones



Legend

- A The location of PDWSAs can be found in DOE’s Drinking Water Source Protection Assessments and Plans or through your regional DOE office, Local Government office, Water Corporation or from the Department for Planning and Infrastructure.
- B Strategically significant sources and potential contamination from land uses close to drinking water reservoirs or abstraction bores are considered first, due to these involving the highest risk of contamination reaching consumers.
- C Current zoning or land use information is available from your Local Government office.
- D Government land is protected to achieve the highest level of safety for drinking water in all parts of a catchment through a Priority 1 classification, wherever this is reasonable and practicable.

Land uses described as 'Compatible with conditions' need ONLY to be referred to DoE for assessment and a written response if the activity does not follow recommendations endorsed by DoE such as those made in policy, environmental management guidelines, protection notes; Ministerial Conditions, Works Approvals, Licenses or agreements (e.g. a 'Memorandum of Understanding' developed between any Local Government and DoE).

'**Incompatible**' - means the land use is UNACCEPTABLE to DoE as it does not meet the management objectives of the priority classification area. DoE will normally oppose approval of these land uses through the planning decision making process and under legislation administered by DoE. If planning decisions are made to approve these land uses (e.g. as a consequence of a planning appeals process), then DoE should be advised of that decision and have been directly involved in providing advice to the planning decision makers on water quality protection issues. It should be noted that contentious proposals may be referred to the EPA for Environmental Impact Assessment under the *Environmental Protection Act 1986*.

'**Extensive**' - means limited additional inputs beyond those supplied by nature are required to support the land use, e.g. for agriculture- animal feed supplements only during seasonal dry periods, or during the final preparation of stock for the market.

'**Intensive**' - means regular additional inputs are required to support the desired land use, e.g. for agriculture- irrigation, fertilisers, pesticides, or non-forage animal feeding dominates.

Interpretation of land use recommendations for planning schemes and development approvals

When using the following land use compatibility tables to guide planning schemes and development approval decisions, the following relationships should be used:

- a) Where the table identifies a land use as '**Acceptable**', this use is permitted by DoE within that priority classification area. It may be identified as a 'P' (permitted) use in a scheme, providing the use complies with the relevant development standards and requirements of the planning scheme.
- b) Where the table identifies a use as '**Compatible with conditions**', this use should be a discretionary use within the priority classification area and should be identified as either a 'D' or 'A' (after special notice) use in the scheme. Proposals for '**Compatible with conditions**' uses should ONLY be referred to DoE for assessment and response if they do not meet existing agency policy, guidelines or protection note measures, unless prior agreement has been made between a specific local government and DoE on alternative measures.
- c) Relevant environmental management guidelines, codes of practice, water quality protection notes or agreements should be used in the first instance to define DoE's position on any land-use and limit the need to refer proposals to the DoE. Where these do not exist, site specific advice may be provided by the DoE.
- d) Where the table identifies a use as '**Incompatible**', that use should not be permitted within that priority source protection area, and should be identified as an 'X' (unacceptable use) in the scheme.

Where the table does not include a proposed land use that could affect water quality, that use should be considered to be '**Incompatible**' until the proponent can demonstrate that it meets the drinking water quality protection objective of the designated priority classification area. Specific advice on the proposed land use should be obtained from the DoE's Water Source Protection Branch.

If the land use planning approval process supports a proposal that is inconsistent with this water quality protection note, then DoE Water Source Protection Branch should be advised of this situation and the reasons for that decision. This advice will trigger DoE's assessment of the significance/ consequence of that decision to the drinking water source and the outcome will be considered in future strategies for water quality protection, and in the periodic review and update of this note. A means to ensure the DoE's effective early involvement with such cases is currently being developed.

Tables defining compatibility of various land uses within PDWSA

It is important to note that this table provides the DoE's recommended compatibility of land uses for the current zoning of land. It must not be used to support rezoning of land to provide for more intensive land uses. For example, although P3 areas provide for high density urban development when the land is already zoned Urban or Urban deferred, this Table must not be read to justify a zoning change within P3 areas to allow for high density urbanisation of rural zoned land.

Model Scheme Text (MST) land uses are shown in **bold** in the first column. Definitions covered in the MST (see note 23) can also be found in the *Town Planning Amendment Regulations 1999*.

Model Scheme Text & interpreted type of land use	P1 areas	P2 areas	P3 areas
Agriculture – extensive - pastoral leases - floriculture (non-irrigated), stock grazing (excluding pastoral leases) and broad hectare cropping	Compatible with conditions Incompatible	Acceptable Compatible with conditions (see notes 11, 12)	Acceptable Acceptable
Agriculture -intensive - aquaculture (fish, plants and crustaceans) - orchards; production nurseries – potted plants; viticulture– wine and table grapes - floriculture; market gardens (see note 24); turf farms - hydroponic plant growing - plant nurseries / garden centres	Incompatible Incompatible Incompatible Incompatible	Compatible with conditions Compatible with conditions Incompatible Compatible with conditions Compatible with conditions (see note 2)	Compatible with conditions Acceptable Compatible with conditions Compatible with conditions Acceptable
Agro-forestry	Incompatible	Compatible with conditions	Acceptable
Amusement parlour	Incompatible	Incompatible	Acceptable (see note 1)
Animal establishment - animal saleyards and stockyards (see note 13) - apiaries - catteries - dairy sheds - dog kennels - equestrian centres (see note 17) - feedlots, intensive outdoor livestock holding - stables (see note 18)	Incompatible Compatible with conditions Incompatible Incompatible Incompatible Incompatible Incompatible	Compatible with conditions (see note 2) Acceptable Acceptable Compatible with conditions (see notes 2, 3, 12) Compatible with conditions Incompatible Incompatible Compatible with conditions	Compatible with conditions (see note 2) Acceptable Acceptable Compatible with conditions (see note 3) Compatible with conditions Acceptable Compatible with conditions Acceptable
Animal husbandry - intensive - piggeries - poultry farming - housed	Incompatible Incompatible	Incompatible Compatible with conditions	Incompatible Compatible with conditions

Model Scheme Text & interpreted type of land use	P1 areas	P2 areas	P3 areas
Bed and breakfast (accommodating a max of 6 guests) - farm stay accommodation, rural chalets)	Compatible with conditions (see notes 6, 16) Compatible with conditions (see notes 6, 16)	Acceptable (see note 23) Compatible with conditions (see note 4)	Acceptable Acceptable
Betting agency	Incompatible	Compatible with conditions (see note 2)	Acceptable (see note 1)
Caravan park	Incompatible	Incompatible	Compatible with conditions (see note 1)
Caretakers dwelling	Compatible with conditions (see note 2)	Compatible with conditions	Acceptable
Car park	Incompatible	Compatible with conditions (see note 2)	Acceptable
Cemeteries	Incompatible	Incompatible	Compatible with conditions
Child care premises	Incompatible	Compatible with conditions (see note 2)	Acceptable (see note 1)
Cinema/theatre	Incompatible	Incompatible	Acceptable (see note 1)
Civic use	Incompatible	Compatible with conditions (see note 1)	Acceptable (see note 2)
Club premises - sporting or recreation clubs - health centres	Incompatible Incompatible	Compatible with conditions Incompatible	Acceptable (see note 1) Acceptable (see note 1)
Community purpose - community halls - irrigated golf courses or recreational parks - motor-sports (permanent racing facilities) - public swimming pools/ aquatic centres	Incompatible Incompatible Incompatible Incompatible	Compatible with conditions (see note 2) Incompatible Incompatible Incompatible	Acceptable Compatible with conditions (see note 11) Compatible with conditions Compatible with conditions

Model Scheme Text & interpreted type of land use	P1 areas	P2 areas	P3 areas
- rifle ranges	Incompatible	Compatible with conditions	Acceptable
Consulting rooms	Incompatible	Compatible with conditions (see note 2)	Acceptable (see note 1)
Convenience store	Incompatible	Compatible with conditions (see note 2)	Acceptable (see note 1)
Corrective institution	Incompatible	Incompatible	Compatible with conditions (see note 1)
Educational establishment - community education centres, scientific research institution - primary / secondary schools, tertiary education facilities	Compatible with conditions (see note 2) Incompatible	Compatible with conditions (see note 2) Incompatible	Acceptable (see note 1) Acceptable (see note 1)
Exhibition centre	Incompatible	Incompatible	Acceptable (see note 1)
Family day care	Incompatible	Acceptable (see note 19)	Acceptable (see note 1)
Fast food outlet	Incompatible	Incompatible	Acceptable (see note 1)
Forestry (native forest/ silviculture/ tree farming)	Compatible with conditions (see note 11)	Compatible with conditions (see note 11)	Acceptable
Fuel depot (storage/ transfer)	Incompatible	Incompatible	Compatible with conditions
Funeral parlour	Incompatible	Incompatible	Acceptable (see note 1)
Home business	Incompatible	Acceptable (see note 20)	Acceptable (see note 1)
Home occupation	Compatible with conditions (see note 15)	Acceptable (see note 21)	Acceptable (see note 1)
Home office	Compatible with conditions (see note 15)	Acceptable	Acceptable
Home store	Incompatible	Compatible with conditions	Acceptable (see note 1)
Hospital	Incompatible	Incompatible	Compatible with conditions (see note 1)
Hotel (includes hotels, hostels, resorts)	Incompatible	Incompatible	Acceptable (see note 1)

Model Scheme Text & interpreted type of land use	P1 areas	P2 areas	P3 areas
Industry			
- abattoirs	Incompatible	Incompatible	Incompatible
- cottage	Compatible with conditions	Compatible with conditions	Acceptable
- drinking water treatment plant	Compatible with conditions	Compatible with conditions	Compatible with conditions
- extractive, includes construction/ mining camps (see note 10)	Compatible with conditions	Compatible with conditions	Compatible with conditions
- food processing, dairy product factories, breweries	Incompatible	Incompatible	Compatible with conditions (see note 1)
- general (chemical manufacture/ formulation, dry cleaners, dye works, laboratories, photo-processors)	Incompatible	Incompatible	Compatible with conditions see note 1)
- general (metal production/ finishing, pesticide operator depots, heavy or energy industry, petroleum refineries)	Incompatible	Incompatible	Incompatible
- general (concrete batching, cement products, fertiliser manufacture/ bulk storage, wrecking)	Incompatible	Incompatible	Compatible with conditions
- general (mineral processing)	Incompatible	Incompatible	Compatible with conditions (see note 9)
- light industry	Incompatible	Incompatible	Compatible with conditions (see note 1)
- milk transfer depots	Incompatible	Incompatible	Compatible with conditions
- mining (includes mineral and energy exploration, oil or gas extraction/ decontamination for transport)	Compatible with conditions (see note 9)	Compatible with conditions (see note 9)	Compatible with conditions (see note 9)
- mining (tailings dams)	Incompatible	Incompatible	Compatible with conditions (see note 9)
- mining (includes construction/ mining camps), (see note 10)	Compatible with conditions	Compatible with conditions	Compatible with conditions
- rural (animal product rendering works, tanneries, wool scourers)	Incompatible	Incompatible	Incompatible
- rural (farm supply centres, manure stockpiling/processing facilities)	Incompatible	Compatible with conditions (see note 2)	Compatible with conditions
- rural (forestry products processing – chip mills, pulp/ paper, timber preservation, wood/ fibre works, composting/ soil blending - commercial)	Incompatible	Incompatible	Compatible with conditions
- service industry	Incompatible	Incompatible	Compatible with conditions

Model Scheme Text & interpreted type of land use	P1 areas	P2 areas	P3 areas
Landfill (solid waste disposal) - class I (refer also to 'Storage - used tyres' advice) - class II or III - class IV or V	Incompatible Incompatible Incompatible	Incompatible Incompatible Incompatible	Compatible with conditions Incompatible Incompatible
Lunch bar	Incompatible	Compatible with conditions (see note 2)	Acceptable (see note 1)
Major transport infrastructure (roads, railways)	Incompatible	Compatible (see note 14)	Acceptable with conditions
Marina (includes boat moorings and servicing)	Incompatible	Incompatible	Compatible with conditions
Marine filling station (boat fuelling)	Incompatible	Incompatible	Compatible with conditions
Market (food; general produce; second-hand goods)	Incompatible	Incompatible	Acceptable (see note 1)
Medical centre	Incompatible	Incompatible	Acceptable (see note 1)
Motel	Incompatible	Incompatible	Acceptable (see note 1)
Motor vehicle, boat or caravan sales (sales yards)	Incompatible	Incompatible	Acceptable (see note 1)
Motor vehicle repair	Incompatible	Incompatible	Compatible with conditions
Motor vehicle wash	Incompatible	Incompatible	Compatible with conditions
National and regional parks and nature reserves	Acceptable	Acceptable	Acceptable
Night club	Incompatible	Incompatible	Acceptable (see note 1)
Office	Incompatible	Compatible with conditions	Acceptable (see note 1)
Park home	Incompatible	Incompatible	Compatible with conditions (see note 1)
Place of worship	Incompatible	Incompatible	Acceptable (see note 1)
Plantation	Compatible with conditions (see note 11)	Compatible with conditions (see note 11)	Acceptable (see note 11)
Reception centre	Incompatible	Incompatible	Acceptable (see note 1)
Recreation – private (within non-designated recreation areas on Crown land)	Incompatible	Incompatible	Acceptable

Model Scheme Text & interpreted type of land use	P1 areas	P2 areas	P3 areas
Residential building - house	Compatible with conditions (see note 16)	Acceptable (see note 4)	Acceptable (see note 4)
- group dwellings (aged and dependent persons)	Incompatible	Incompatible	Acceptable (see note 1)
Restaurant	Incompatible	Incompatible	Acceptable (see note 1)
Restricted premises (adult interests)	Incompatible	Incompatible	Acceptable (see note 1)
Rural pursuit	See Agriculture, Animal establishment or husbandry		
Service station (includes aircraft, automotive repairs, boats, mechanical plant, service stations at transport and municipal works depots)	Incompatible	Incompatible	Compatible with conditions (refer to note 1)
Shop	Incompatible	Compatible with conditions (see note 2)	Acceptable (see note 1)
Showroom	Incompatible	Incompatible	Acceptable (see note 1)
Storage - used tyres (see note 22) - chemical storage in under ground tanks - chemical storage in above ground tanks	Incompatible Incompatible Incompatible	Incompatible Incompatible Compatible with conditions	Incompatible Compatible with conditions Compatible with conditions
Tavern	Incompatible	Incompatible	Acceptable (see note 1)
Telecommunications infrastructure	Compatible with conditions	Compatible with conditions	Compatible with conditions
Toilet blocks and change rooms	Compatible with conditions (see note 2)	Compatible with conditions	Acceptable
Trade display	Incompatible	Incompatible	Acceptable (see note 1)
Veterinary centre	Incompatible	Compatible with conditions (see note 2)	Compatible with conditions (see note 1)
Warehouse	Incompatible	Compatible with conditions (see note 2)	Compatible with conditions (see note 1)
Waste transfer station (includes recycling depots)	Incompatible	Incompatible	Compatible with conditions

Model Scheme Text & interpreted type of land use	P1 areas	P2 areas	P3 areas
Wastewater infrastructure - sewerage – gravity sewers - sewerage – pressure mains - sewer pump stations - treatment plants, wastewater disposal to land - wastewater injection into the ground (see note 25)	Incompatible Incompatible Incompatible Incompatible Incompatible	Incompatible Compatible with conditions Compatible with conditions Incompatible Incompatible	Acceptable Acceptable Compatible with conditions Compatible with conditions Compatible with conditions Incompatible
Water treatment plants (drinking)	See Industry		
Winery (includes wine tasting facilities)	Incompatible	Compatible with conditions (see notes 3 & 5)	Compatible with conditions (see note 3)

Table recommending compatibility of land subdivision within PDWSA: Note - This table reflects the recommended size of a subdivision based on the existing zoning and the priority classification area status of land. It should be noted that Town Planning Scheme provisions for specific zones and reserves will take precedence over the following recommended lot sizes.

Form of subdivision (specific to current zoning)	P1 areas	P2 areas	P3 areas
Rural subdivision - to a lot size of 4 hectares or greater - to a lot size less than 4 hectares	Incompatible Incompatible	Acceptable Incompatible	Acceptable Incompatible
Special rural subdivision - to a lot size of 2 hectares or greater - to a lot size between 1 and 2 hectares - to a lot size less than 1 hectare	Incompatible Incompatible Incompatible	Compatible with conditions (see notes 7 & 8) Incompatible Incompatible	Compatible with conditions (see note 8) Compatible with conditions (see notes 7 & 8) Compatible with conditions (see note 7)
Urban subdivision Industrial subdivision	Incompatible Incompatible	Incompatible Incompatible	Acceptable (see note 1) Acceptable (see note 1)

Explanatory notes related to land uses described the tables:

The following notes provide interpretive information based on the scale or type of development described in the preceding tables. They do not list all the conditions that could apply to any activity or development.

1. Must be connected to deep sewerage, except where exemptions apply under State Government Sewerage Policy. The Policy recognises that sewer connection may be impractical in some areas. Under these circumstances maximum wastewater loadings (based on people/ hectare) apply linked to the management Priority of the site.
2. The land use is normally incompatible, but may be conditionally approved where this facility is consistent with approved State and local government planning strategies or schemes.
3. The land use must incorporate best environmental management practices compatible with the management strategy for the designated priority area defined in the relevant source protection plan.
4. In Priority 2 areas: conditions may apply to density of dwellings (i.e. hectares per dwelling).
5. Size of the grape crush shall not exceed 500 tonnes per year.
6. May be approved if occupancy is of equivalent size to a single dwelling household (i.e. less than 10 people– defined by capacity of a septic tank based on-site wastewater treatment system).
7. An average, rather than minimum, lot size may be accepted if the proponent can demonstrate that the water quality objectives of the source protection area are met, and caveats/memorials are placed on titles of specified blocks stating that further subdivision shall not occur.
8. Lots should only be created where land capability assessment shows that effective on-site soakage of treated wastewater can be achieved. Conditions apply to siting of wastewater disposal systems in areas with poor land drainage and/ or a shallow depth to groundwater, animals are held or fertiliser is applied. Alternative wastewater treatment systems, where approved by the Department of Health, may be accepted with ongoing maintenance requirements.
9. Conditions are likely to be placed via a Department of Industry and Resources mineral tenement lease, and / or as a result of Minister for the Environment's approval after an Environmental Impact Assessment.
10. Conditions apply to the storage of fuels and chemicals, the depth of excavation related to the water table and rehabilitation criteria. Underground fuel or chemical storage tanks are prohibited via DoE by-laws in Priority 1 and 2 areas within Underground Water Pollution Control Areas.
11. Conditions apply to regulate fertiliser and pesticide application.
12. Can be approved if animal stocking levels (animals per hectare, guided by the Department of Agriculture's stocking rate guidelines) are consistent with the priority source protection area objectives.
13. This does not include stockyards occasionally used on farms or pastoral leases for animal husbandry.
14. Conditions may be imposed to cover design, construction of infrastructure and the types of goods.
15. May only be approved if *Home Occupation* relates to an existing residence.
16. Limited to one residential building per property.

17. Includes land or buildings dominantly used for the showing, competition or training of horses, and riding schools.
18. Includes any land, building or structure used for equine (e.g. horses, asses, mules and donkeys) housing, keeping and feeding and associated activities.
19. In accordance with *Community Services (Child Care) Regulations 1988: A child care service provided to a child in a private dwelling in a family of or domestic environment. No more than 5 children of pre-school age and no more than 7 children under 12 years old, including the children of the licensee or permit holder.*
20. No more than 2 employees, and the home business occupies an area up to 50 square metres. Compatible if only an office/ administrative business (i.e. overnight parking of only one commercial vehicle, no refuelling or repair/ maintenance of business vehicles, and no activities involving on-site use storage or disposal of chemicals or process wastewater).
21. Employees shall be members of the household, and the home business occupies an area of up to 20 square metres. No provision for refuelling, repair or maintenance of commercial/ business vehicles or on-site use or storage of chemicals.
22. Used tyre use, storage and disposal are subject to *Used Tyre Regulations 1996*, administered by the this agency.
23. As defined in the Model Scheme Text (1997) or the *Residential Design Codes of Western Australia (2002)* prepared by the Western Australian Planning Commission, and covering local government planning schemes.
24. Applies to the commercial production of horticultural crops e.g. vegetables, flowers and fruit crops grown in contact with the ground. Does not apply to cereal or oil seed crops, perennials e.g. orchards, vineyards, nuts; or any crop grown separate from contact with soils in the natural environment e.g. hydroponics.
25. The use of recycled (reclaimed) water to address the diminishing level of scheme water supply in Western Australia is currently being investigated by Government. The social, environmental, health and economic issues related to this option are significant and need to be further progressed before its applicability in PDWSA is reconsidered.

More information or feedback

More information about recommended best management practices is available in Environmental Management Guidelines and Water Quality Protection Notes for some of the listed land uses. These are available on DoE's Internet site <http://drinkingwater.environment.wa.gov.au> or by contacting DoE regional offices.

We welcome your comments on this note. The note will be updated from time to time as feedback is received or land-use activity standards change. For the most up to date version of this note, please refer to <http://www.environment.wa.gov.au>. If you wish to discuss this note, please contact DoE Water Source Protection Branch at the Hyatt Centre in East Perth. Phone: (08) 9278 0300 (business hours); Fax: (08) 9278 0585; or E-mail: use {feedback} section at DoE Internet address <http://www.environment.wa.gov.au> citing the topic and version.

Appendix 4 - Best management practice documents for activities in PDWSAs

BEST MANAGEMENT PRACTICE DOCUMENTS FOR ACTIVITIES IN PDWSAS

Waste management:

- Health Department of Western Australia, 6/1999, *Understanding Septic Tank Systems*. Environmental Health Guide, Environmental Health Service EHS 29. Available from <www.population.health.wa.gov.au/environmental/resources/Septic%20tank%20systems.pdf>.
- Health Department of Western Australia, 9/1998, *Aerobic Treatment Units*. Environmental Health Guide, Environmental Health Service EHS 26. Available from <www.population.health.wa.gov.au/environmental/resources/Aerobic%20treatment.pdf>.
- Agriculture & Resource Management Council of Australia and New Zealand and Australian and New Zealand Environment and Conservation Council, 1994 to 2000, Paper Nos 11 – 15 *Australian Guidelines for Sewerage Systems*, ARMCANZ & ANZECC.

Drainage:

Overland runoff should not be channelled into streams. Infiltration into soil should be aided at every opportunity.

- Lloyd, B. and Van Delft R., 2001, *Erosion and Sediment Control Manual for the Darling Range, Perth Western Australia*. Upper Canning/Southern Wungong Catchment Team, Agriculture WA.

Buffers:

Vegetated buffers should be maintained along all streamlines, whether currently flowing or not.

- Example in Section 4.1: Department of Conservation and Land Management, 1999, *Manual of Management Guidelines for Timber Harvesting in Western Australia*, Department of Conservation and Land Management. Available from: www.naturebase.net/forest_facts/sy_review/manuals/manual_of_harvesting_specifications/index.html.
- National Health & Medical Research Council and Agriculture & Resource Management Council of Australia and New Zealand, 2004, *Australian Drinking Water Guidelines*, NHMRC and ARMCANZ. Available from: <www.nhmrc.gov.au/publications/synopses/eh19syn.htm>.
- Water and Rivers Commission, 2001, *A Review of Stream and River Logging Buffers in Western Australia, to Ensure their Adequacy in Protecting Waterways from Salinity, Degradation and Turbidity*, Water and Rivers Commission report to the Conservation Commission of Western Australia.

Pesticide application:

Should be minimised in catchment areas. For specific needs of crops and best practice contact Department of Agriculture.

- Department of Environment, 2004, Water Quality Protection Note *Pesticide Use in Sensitive Environments* (draft), Water and Rivers Commission.
- Department of Health, 1993, Public Service Circular 88 *Use of Herbicides in Water Catchment Areas*, Government of Western Australia. Available from:
<www.population.health.wa.gov.au/environmental/resources/use%20of%20herbicides%20in%20water%20catchment%20areas.pdf>.
- Water and Rivers Commission, 2000, Statewide Policy No. 2 *Pesticide Use in Public Drinking Water Source Areas*, Water and Rivers Commission. Available from:
<<http://drinkingwater.environment.wa.gov.au>>.

Nutrient application:

Nutrient application should be minimised in catchment areas. For specific needs of crops contact the Department of Agriculture

- Water and Rivers Commission, 1998, Water Quality Protection Note *Nutrient and Irrigation Management Plan*, Water and Rivers Commission. Available from:
<<http://drinkingwater.environment.wa.gov.au>>.

Forest management:

- Department of Conservation and Land Management, 1999, *Code of Practice for Timber Harvesting in Western Australia*, Department of Conservation and Land Management. Available from:
(www.naturebase.net/forest_facts/sy_review/manuals/index.html>).
- Forest Products Commission, 2003, *Contractors' Timber Harvesting Manual – South West Native Forests*, FPC.

Forest fire management:

Controlled burning should be conducted on a scale and at a frequency to minimise erosion from overland runoff into reservoirs. Therefore, only small proportions of land in a catchment should be burnt in any one year. Guidelines on how to address water quality protection objectives in the Controlled Burning Prescription should be documented by CALM, DoE and WC.

Bauxite mining:

- Alcoa World Alumina Australia, 2005, *Environmental Management Manual, Bauxite Mining Operations*, Alcoa World Alumina Australia.
- McIntosh, K.S. and Cronin, D.J., 2003, *Bauxite Mining in Water Supply Catchments – Water Conservation and Quality Protection*, Alcoa World Alumina Australia.
- Water and Rivers Commission, 2000. Water Quality Protection Guidelines (Nos 1 – 11): *Mining and Mineral Processing*, Water and Rivers Commission. Available from:
<<http://drinkingwater.environment.wa.gov.au>>.

Recreation:

Recreational trails in PDWSAs must be constructed and maintained to prevent track erosion. Campsites must also be designed to minimise overland runoff and sealed composting toilet facilities provided and maintained.

- Water and Rivers Commission, 2003, Statewide Policy No. 13 *Policy and Guidelines for Recreation within Public Drinking Water Source Areas on Crown Land*, Water and Rivers Commission. Available from: <<http://drinkingwater.environment.wa.gov.au>>.

Research projects:

Participants should be educated on personal hygiene, erosion prevention and water quality protection objectives in a PDWSA prior to entering the catchment.

Major roads, roads and tracks, infrastructure maintenance:

Drainage must be controlled to prevent soil erosion and minimise sediment transport. Chemical application to control vegetation should be minimised

- Lloyd, B. and Van Delft R., 2001, *Erosion and Sediment Control Manual for the Darling Range, Perth Western Australia*, Upper Canning/Southern Wungong Catchment Team, Department of Agriculture.

Extractive industries / gravel pits:

- Department of Conservation and Land Management, 1993, Policy Statement No. 2 *Local Government Authority Access to Basic Raw Materials from State Forest and Timber Reserves*, Department of Conservation and Land Management.
- Department of Conservation and Land Management, 1986, Policy Statement No. 10 *Rehabilitation of Disturbed Land*, Department of Conservation and Land Management.
- Water and Rivers Commission, 2000, Water Quality Protection Note *Extractive Industries within Public Drinking Water Source Areas*, Water and Rivers Commission. Available from: <<http://drinkingwater.environment.wa.gov.au>>.

Chemical and fuel storage:

- Water and Rivers Commission, 2002, Water Quality Protection Note *Toxic and Hazardous Substances Storage within Public Drinking Water Source Areas*, Water and Rivers Commission.
- Water and Rivers Commission, 2002, Water Quality Protection Note *Chemical Spills – Emergency Response Planning*, Water and Rivers Commission.
- Water and Rivers Commission, 2000, Water Quality Protection Note *Temporary Above Ground Chemical Storage within Public Drinking Water Source Areas*, Water and Rivers Commission.
- Water and Rivers Commission, 1999, Water Quality Protection Note *Above Ground Chemical Storage Tanks within Public Drinking Water Source Areas*, Water and Rivers Commission.

- Water and Rivers Commission, 1998, Water Quality Protection Note *Temporary Skid Mounted Fuel Transfer and Storage within Public Drinking Water Source Areas*, Water and Rivers Commission.
- Water and Rivers Commission, 1998, Water Quality Protection Note *Temporary Above Ground Fuel Storage within Public Drinking Water Source Areas*, Water and Rivers Commission.

Available from: <<http://drinkingwater.environment.wa.gov.au>>.

Mechanical servicing and workshops:

- Water and Rivers Commission, 2002, Water Quality Protection Note *Mechanical Equipment Washdown*, Water and Rivers Commission. Available from: <<http://drinkingwater.environment.wa.gov.au>>.
- Water and Rivers Commission, 2002, Water Quality Protection Note *Mechanical Servicing and Workshop Facilities*, Water and Rivers Commission. Available from: <<http://drinkingwater.environment.wa.gov.au>>.

Transport of fuels and explosives:

- Department of Industry and Resources, 2003, GN X503-7 *Vehicle Requirements for the Road Transport of Explosives in Risk Category 3 Quantities*, Department of Industry and Resources.
- Department of Industry and Resources, 2003, GN X511-6 *Vehicle Requirements for the Road Transport of Explosives in Risk Category 2 Quantities*, Department of Industry and Resources.
- Department of Industry and Resources, 2003, GN T1076 *Requirements for Transport of Dangerous Goods in Bulk*, Department of Industry and Resources.

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